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OF

THE QUARTERLY JOURNAL,

N°. XXVII.

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TO CORRESPONDENTS.

WE have mislaid the cover enclosing a communication from Mr. John Reid, and containing his address; this circumstance has prevented our earlier acknowledgment of its receipt. It appears to us that his researches are well contrived, and likely, if pursued, to lead to some important information connected with pharmaceutical chemistry; we therefore think it prudent to withhold his paper for the present, until we hear from him again.

The specimen from Newry, forwarded by Mr. Bell, is *pitchstone*.

F. O. S., from Leadenhall Street, has been received, but we do not understand the object of his letter.

We are sorry to decline the insertion of the letter signed M. R. I.; but its details scarcely come within the objects of this Journal. The subject of gas illumination, however, is, as he justly observes, connected with the "useful applications of science;" and we regret, in common with M. R. I., and the majority of our fellow-parishioners, that the improvements in lighting and paving displayed by the surrounding parishes have hitherto been so obstinately excluded from St. George's. After submitting to the nuisance of laying pipes, and the stench of its general introduction, why should we be deprived of the only compensation, namely, the advantage of its *light* in our streets?

If M. R. I. will limit himself to this subject, we shall be happy not only to insert his communication, but to second his object by all means within our power. We further beg to inform M. R. I., that he is quite misinformed in supposing that we have ever "advised the introduction of coal gas into dwelling-houses."

We have referred to the papers alluded to by "*Anti-Atomicus*," and a few hasty experiments have been sufficient to teach us that he is quite right; but we must "temper justice with mercy."

We have received an anonymous Essay on the Patronage of Science; we agree with the author upon many points, on which indeed there can scarcely be two opinions; but upon others we so widely differ, that we have thought it prudent to withhold the paper for the present.

> Dulcis *inexpertis* cultura potentis amici;
> *Expertus metuit.*

The communication from a correspondent at Edinburgh did not reach us till the present number of the Journal was *half* printed; he will see, therefore, how impossible it was in any way to comply with his request.

We have to apologize to M. for the omission of his letter in our last number, which was accidental.

The letter of our correspondent at Genoa, dated August 1, 1822, has reached us, and we shall be obliged by his proposed paper.

An additional communication from Mr. Parkes, respecting Early Literary Journals, we hope to be able to give in our next number.

We sincerely believe that F.R.S. is correct. If he can find a palatable synonym for a vulgar word which is of frequent occurrence in his letter, we will refer to the authorities quoted, and publish the "illustrations."

We hope that no error of importance has crept into our transcript of M. Berzelius's abominable symbols, or *formulæ*, as he calls them, contained in our article on Foreign Science. If that ingenious and indefatigable chemist persevere in this pedantry, we trust our readers will excuse us if we so far deviate from literal translation in our reports of his papers, as to put the symbols into plain English: we shall look less learned, but be liable to fewer errors of the press.

Communications have been received from Mr. Whitaker of Lambeth; from Messrs. Harvey and Co.; from *Anti-Quack;* from O; and from "a Member of the Apothecaries' Company:" and from S. but they reached us too late to be taken into consideration for this number.

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TO READERS AND CORRESPONDENTS.

"A Subscriber" is informed, that a greater quantity of heat is generated, and consequently a greater quantity of steam raised in a given time, by the *rapid*, than by the slow, combustion of a given quantity of fuel: hence the economy of a quick draught attained by a lofty chimney.

We have been obliged to postpone an Antiquarian Communication from a Correspondent at Birmingham.

A paper from Dawley in Shropshire we must decline inserting, and will therefore dispose of it as the author may choose to direct.

If "A Constant Reader" will take the trouble of referring to *Glauber's Prosperity of Germany*, he will find that we are right.

It is necessary to inform some of our Correspondents, that if we receive no directions respecting communications which are not inserted, they are destroyed upon the publication of the number of the Journal next after the receipt of their papers.

F.R.S. will observe that his request has been complied with.

In the Foreign Science of our last number, most of our readers will probably have observed, that the word *grains* is misprinted for *grammes*. Those who have not already remarked the error, will please to correct it.

Mr. Harvey's paper on the Formation of Mists we reserve for our next number.

In reply to "A Member of the Alfred," and to M. R. I., we must again observe, that this Journal is scarcely a fit channel for the publication of their grievances. We cordially join them in reprobating the disgraceful manner in which the parish of St. George, Hanover-square, is lighted, and we recommend our correspondents upon the subject, as well as others who feel its nuisance and danger, to draw up a petition to the Vestry, where we have little doubt that it will meet with attention; for the neglect with which it has hitherto been treated, arises probably from ignorance of its extent, among those who have the power of remedying it.

In Dr. Yeats's paper (page 345,) the possibility of carbonate of lead being very slightly soluble in water impregnated with carbonic acid, is mentioned. We have, however, found that it is perfectly insoluble under such circumstances; hence, where it operates as a poison, it is *diffused* through the water, but often in so fine a state of division, and so small in quantity, as scarcely to render it perceptibly turbid, and to be a very long time in entirely subsiding.

THE QUARTERLY JOURNAL,

October, 1822.

ART. I. *Narrative of a Journey from Egypt to the Western Coast of Africa, by* Mahomed Misrah. *Communicated by an Officer serving in Sierra Leone.*

To the EDITOR *of the Quarterly Journal.*

Fort Thornton, Sierra Leone, April 8, 1821.

SIR,

AT the request of several of my friends, of one in particular, a correspondent of yours, now on a visit to this colony, I am induced to send you an account of a journey performed by a Mahomedan Priest, over land from Egypt to the western shores of Africa; the details of which I have collected at several recent interviews. The facts were originally noted down for the purpose of gratifying my own curiosity, and of serving me as a guide in crossing Africa from west to east, in an expedition to explore the termination of the Niger, which I have in contemplation should a favourable opportunity offer. The eyes of Europe, generally, have been long turned towards Africa; but the attention of Great Britain, particularly, has been for the last thirty years directed, with a degree of praiseworthy anxiety, towards the prosecution of discovery in that vast continent, the melioration of the condition of her long-neglected inhabitants, their civilization, and the subsequent inculcation of morality and religion: to forward this grand design, worthy the character of such a nation as England, expeditions on the most expen-

sive scale, and on apparently the wisest plans, have been fitted out, and as it were, thrust into Africa from various points; but although neither expense, ingenuity, nor perseverance have been spared, the success has hitherto been so limited from disasters painful to recollect, that we are at this day in possession of little more information than twenty-five years ago, respecting regions still untraversed by Europeans, and known only by reports and occasional information gathered from native travellers, who too often relate as facts, on their own knowledge, what they have only heard from others; and thus furnish matter for hypotheses concerning the interior divisions of this *terra incognita*, and the course of its mysterious river, which has been successively represented to flow towards every point of the compass.

I regret much that the hurry of making arrangements preparatory to conducting a mission into the Solima and Sankara countries, whither I shall set off in a few days, does not allow me sufficient time to put the route of the Priest in a shape more fit to meet the public eye; but I trust that its authenticity, and the care which I have bestowed in sifting the information, will in some measure compensate for this deficiency; and although the matter collected is not of a nature to throw much light on the probable termination of the Niger, yet it may be of consequence in detecting the fallacious opinions of those fanciful speculators, who direct the courses of rivers in their chambers, and eventually draw conclusions, with which they are (naturally enough) satisfied themselves, but which can produce no other effect upon the generality of their readers, than a conviction that the result of their labours is to involve in greater doubt and obscurity a problem which never can be solved but by ocular demonstration.

Mohamed Misrah, a Moslem, was born in Alexandria about forty-five years ago. When a young man, he remembers an army of white-people taking possession of his country, who about three years afterwards were driven from it, having been beaten in a battle with other white people, who spoke a different language. Mahomed was within hearing of the

guns, but did not see the engagement, he, and a great many more of his countrymen having retired from the scene of action through fear. A few years after this period, feeling himself conscientiously impelled to propagate his belief, he set out on a journey westward along the shores of the Mediterranean, and travelled as far as Fez, where, finding an insurmountable barrier in the great desert of Sahara, to his advance to the southward amongst the Kafir nations, he turned his face towards the rising sun, retraced his steps to Alexandria, and (to use his own expressions) sat down there for some time, uncertain as to his future intentions; at length, without any fixed or determinate plan, he departed from Alexandria, and following a southerly course, arrived in nine days at Ariff, four at Dongola, and in ten arrived at Sennaar, a low sandy country, abounding with camels, horses, and cattle; the Nile, which he describes as running from the S. W. or country of the Kafirs, where it bears the name of Baher el Abeed, is about a mile in breadth here, and is slow and majestic in its progress; the natives of Sennaar are Mahomedans, and the king is named Khamadoo.

Turning his back upon Sennaar, the Kolunjumi (Red Sea) and Mecca, he arrived in one day at the eastern frontiers of the kingdom of Kordofan, which is only habitable on the borders, the centre being a desert of ten days' journey across, and not to be traversed during the dry season: here Mahomed was under the necessity of awaiting the departure of a caravan which took some time in collecting, and did not eventually set out till the wet season had been pretty well advanced. In this part of his journey, the Priest suffered much from the scarcity of water, that which they carried in skins having evaporated, and there being no oasis or well in the desert, at which they could procure any; in this dilemma, they spread their garments at night on the sand to catch the rain or dew, and in the morning, a scanty supply was procured by squeezing them; which (says the Priest) is the practice always resorted to in such cases, and it is for the sake of this advantage, that the journey is always performed during the rains. The king of Kordofan is named Musa Báh, and his subjects are rigid Mahomedans.

After having traversed this desert, which occupied eleven days, and having skirted the northern boundaries of Dar Fur, he found himself at Noomdroo, the most eastern town of Wadda, or Dar Bergoo; in fifteen days more, pursuing a direction to the N. W. he arrived at Warra, the capital of that country. This is a very powerful kingdom, and of much greater extent from east to west than is generally represented in the maps; the sovereignty is held by Saboo, a prince of unlimited authority, who occasionally sends large armies into the field, but seldom accompanies them himself; his troops are not furnished with fire-arms, but they maintain desperate conflicts with the spear, an instrument which they direct with much precision, and handle with great dexterity: many of the natives of Wadda are great travellers, and trade to countries far distant; their beasts of burthen, like as in most of the sandy districts of Africa, is the camel. From Warra proceeding to the northward of west, in two days he fell in with Fitrée Alfitrée or Belála, situated on the large lake of that name; this lake receives the contents of a large river (perhaps the Gir of Ptolemy, the Baher el Miselad of Browne) which rising among some small mountains or hills on the confines of Kordofan, flows to the westward through Dar Fur, and afterwards in a north-westerly direction till it reaches its termination where its breadth is about four hundred yards. Mahomed has made the circuit of lake Fitu, and positively declares, that it has no outlet; this stubborn fact, may (with the sequel of his route, which is perfectly consistent, and shews that he crossed no river of any magnitude between Fitri and Nufi) prove a serious objection to the continuation of the Gir, which has been lately supposed to flow from Lake Fitri, and after traversing an immense extent of country, to unite with the Niger, and thus account for the quantity of rain-water, which finds its way to the Bight of Benin through the broad channels of its numerous rivers. The soil around Lake Fitri during the dry season is soft and slimy, owing to the retiring of the water, and at this time, myriads of musquitoes are engendered, which cause a visit to its banks to be very disagreeable. The natives of the country are Mahomedans, carry

on a great trade with the Arabs, but are subject to the kingdom of Wadda, to which they pay an annual tribute.

A journey of one day north-west, brought the Priest to Baghermi, a fertile country, of which he says little. The prevailing religion of the inhabitants is Mahomedanism; they trade with the Arabs, and pay tribute to Bornou: he reached Katucko in one day more, and rested the day following at Mandara, where he found himself only one day to the eastward of Bornou Brinée, the principal town of the extensive kingdom of that name; Katucko and Mandara are both dependant upon Bornou; the chief or headman of the latter is known by the name of Abdul Lahi. Bornou Brinée is a large and populous town, and is much resorted to from all parts of northern Africa; the merchandise, however, is entirely conveyed to it upon camels and horses, and Mahomed Misrah declares there is no river of consequence within ten days' march of it: being questioned as to its distance from the Niger, he pointed towards the south, saying, "Three days will carry you to Mooskoo, and seven days to the country of the Kafirs; the Joliba runs through that country, but is known there by a different name." That part of the kingdom of Bornou through which he passed, (with the exception of Brinée which is surrounded with sand,) is more fertile than any he met with during the whole of his journey; abundance of vegetable provision and plenty of fine corn are produced, and extensive pasturages crowded with cattle are seen in all directions. The natives are Moslems, and their king, Ahamdoo, receives tribute from most of the circumjacent nations.

Departing westward from Bornou Brinée, he arrived in three days at Angaroo; one day S. W. by W. brought him to Tassina, three days west to Awoyak, and three days W. by S. to Kano, كق generally written Cano, Ghano, and Gano; all these countries are flat, clear of brushwood and bush, and like Bornou produce plenty of corn. Kano is a kingdom which ranks high among the nations of northern central Africa, and every thing said of it by the Priest corroborates the statements already given by others; the natives are amazingly adventurous and persevering; they trade to Nufi, Timbuctoo, and various other remote countries

situated along the north bank of the Niger, the inhabitants of which are known by the appellation of Muley Ismahel's people, a great Arab chief, whose empire extends along the southern skirts of the great desert. He performed the journey from Kano to Kashana كشت, generally written Kashna and Kassina, in five days, travelling W. by S. through districts sometimes verdant, occasionally sandy; the natives are Mahomedans, of a very deep black complexion, of commercial habits, and not disposed to quarrel, or make war; the country of Zanfara lies to the southward of Kashana, according to information received there by the Priest.

Proceeding in a direction considerably to the southward of west, he arrived after a tedious journey of twenty days at the town of Nufi, situated on the Niger, which is here called Kuorra كرة, is only about four hundred yards broad, and pursues a course a little to the southward of east with great rapidity, into the nations of the Kafirs. On his route from Kashana, he passed many inconsiderable rivers running from north to south, traversed a country tolerably clear and fertile, though occasionally interspersed with extensive deposits of sand, and as he approached Nufi, met with many villages, at all of which he received cordial welcome, being inhabited by tribes of the purest Mahomedan faith. Nufi is but an insignificant town, and is full of pagans, a circumstance which appeared to have given Mahomed great concern; it is situated on the left bank of the Niger, and further from its source than Boussa, where many coinciding reports agree, that our unfortunate countryman, Mungo Park lost his life by shipwreck*. He asserts most positively, that the river runs due east from Boussa to Nufi, and inclines a little to the southward after leaving the latter town; circumstances which

* The following statement of a native of Yawoori, now residing in Sierra Leone, is given nearly in the manner in which it was related in my presence, October, 1821. "My name is Duncanoo, I was born at Brinée Yawoori, and was there about sixteen or seventeen years ago, when a ship with two masts made her appearance on the Joliba. As she seemed to be passing the town, and as the king was desirous of knowing what people were in her, he sent off eight canoes (in one of which was a red bull,

operate rather forcibly against the validity of Reichard's old hypothesis, now newly brushed up, and become the favourite opinion of the day. To the northward and eastward of Nufi, the country is very mountainous and bold, and it is from thence that all the small rivers which he crossed in his journey from Kushana derive their origin; this high land is called Ksekseh

intended as a present) to inquire; but the people on board, some of whom were white, would not permit them to approach, and as they continued following, subsequently fired upon them, but did not kill any. The king of Yawoori was sorry they had mistaken his intentions, for being anxious on account of their safety, he wished to shew them the right channel of the river, which near Boussa, becomes very rocky, and difficult to navigate. After the vessel had passed Yawoori, most of the inhabitants left the town, and went to Boussa (which is one day's journey by land, and thirty-six hours by water) to witness the disaster which they knew by experience would there occur. On their arrival at Boussa they perceived the ship coming down the stream with a rapidity which increased as she drew near to the fatal rocks and cataracts, till at last becoming quite unmanageable, the confusion on board was seen to be very great. When the vessel struck, she went to pieces so immediately, that they could only save one man, who was a black slave, and spoke the Foulah language; this black man was detained at Boussa, but no person was either landed or kept a prisoner at Yawoori *. Just as the vessel struck, one of the white men (supposed to be Park) seemingly much agitated, threw something into the water, and having followed it, soon disappeared; the rest shared the same fate, it being utterly impossible to contend against the impetuosity of the river at this place. The people at Boussa picked some guns and pistols out of the water, by means of diving with ropes fastened round their bodies, an exercise at which they are very expert. The river at Boussa is very broad, and admits of a safe passage through the rocks, with which the natives are well acquainted." About a year after this occurrence, while on a trading journey, Duncanoo was seized upon by the Foulahs, and carried to the Gold Coast, which occupied a journey of nearly two moons; he does not remember having crossed any high ground on the way, but he came a great part of the way by water. On his arrival at the coast, he was sold and shipped on board a Portuguese vessel, which conveyed him to Bahia, where he remained for three years, and was then put as a seaman on board a slaver, which was captured on the coast of Africa by Captain Mill in Governor Maxwell's time, and brought into Sierra Leone, where he was liberated.

* This would appear to contradict Amadoo Fatima's statement, as given by Isaaco.

كسكس To the westward, between Houssa and Yawoori, is situated on the Niger, a town of immense magnitude and importance called Kuku, of the power of which the surrounding tribes stand much in awe.

In one day's march S. W. from Nufi, Misrah reached Yarraba, where he states that a singular trade is carried on, between the natives and a tribe of white people, said to be Christians, who come down a river which flows into the Niger from the southward, and exchange commodities without personal intercourse. Concerning this improbable, and (if true) almost unaccountable story, which is related by many native travellers, as well as the Priest, and which occupies a page or two in the travels of almost every European who has ever ventured beyond the sight of the ocean into this forbidden country, I questioned Mohamed Misrah for some time before I learned that he himself had never seen either the white people in question, or their mode of carrying on trade: and on my expressing surprise that curiosity did not induce him to witness a scene so singular, he observed with much indifference, that as the people of the one country were pagans, and those of the other were Christians, he, as a Mahomedan, was not very anxious to hold communication with either. When a story is once promulgated in Africa, it is never lost sight of; on the contrary it becomes established more firmly by age, and the perfectly fictitious, improbable and absurd, is actually believed by the very inhabitants of the place, where the circumstance is said to exist; indeed, such is the power of this extraordinary credulity, that they will be highly offended with any one, who may attempt to convince them of its fallacy; repeated instances of this nature, though of minor import, have been experienced by myself during some short excursions among the Timmanees and Mandingoes, in particular once at Cambia, on the Kolenti Ba (Scarciès) when having broken a specimen of granite from a large block in the centre of the river, I endeavoured, at the Palaver, which the natives called in consequence, to explain to them how absurd it was to suppose the existence of any evil spirit in a rock; upon this occasion their anger was so stirred up,

that I found it a difficult matter to change the subject, and bring them back to good humour. The specimen in question was not procured without considerable difficulty, for even the men whom I had with me from Sierra Leone, refused to row me to the spot.

To return to the Priest; in five days after leaving Yarraba, he reached Azzugo, situated in a country flat, sandy and barren; he then proceeded W. by S. to Goingia, a journey of ten days, through a barren country, to the southward of which lies Dahomy, a very bad country, where he understands people eat one another; four days west through beautiful and well cultivated regions, abounding with every description of provisions brought him to Degumba, to the left of which are to be descried lofty mountains, extending along the horizon as far as the eye can reach; these are of course the mountains of Kong, which were formerly supposed to stretch across the whole breadth of Africa; along the road to Degumba, numbers of women are to be met with inhabiting booths, in which the traveller may repose, and be regaled with milk, fruit, and other refreshments, in exchange for kolas and kowries; the former, a fruit, so much prized by all Africans, grows abundantly here, and is the means of attracting the surrounding nations, who flock in great bodies to Degumba for the purpose of procuring it in exchange for European and African produce. Gourma is the next place at which our Priest arrived, having travelled in a direction a little to the southward of east, passing through many small towns and villages, and a country rather fertile than otherwise; three days more, pursuing the same course, brought him to Mousi, a country which produces almost every article of food required by the African, excepting kolas, to get which they are obliged to trade to Degumba; and although the distance is so trifling, yet such is the estimation in which that article is held, that six or seven are said to be a handsome price for a fine Mousi horse: this noble animal is very plentiful in this part of Africa, and arrives at great perfection, growing larger and stronger than at any other place which the Priest has visited. The principal vegetable productions of Mousi, as well as of

those countries which he passed through after crossing the Niger at Nufi, are yams, rice, and corn, the latter of which grows luxuriantly in most of the interior regions: the natives of those districts are a mixture of converts and pagans, but Mahomed regrets that while the proportion is materially in favour of Paganism, the Mahomedans are not very firm in their faith. From Mousi, turning towards the north-west, and passing through various small towns and villages, about a day's journey from one another, he arrived at Jenne, or Janne, جنى in fifteen days, but did not fall in with any river running to the northward; therefore we must still allow Park to be correct in laying down the land of Jimbala as an island formed by the separation of the waters of the Niger. This place, though not as yet visited by any white person, is known to us as a large, important, and well-built town; it is situated at the termination of a creek, which encroaches on the right bank of the Niger, is a great mart for the exchange of all kinds of African produce and European manufacture, has a regular market-place, and is much frequented by the Moors, who resort to it in large parties with loaded camels. Janne is not, however, an independency, being much under Moorish control, who, it is said, appoint and dismiss at pleasure a governor, or dharaboo, who, during his administration, has as much authority as any independent chief. Timbuctoo is governed in like manner, its superintendent being appointed by Muley Ismahel, the great Arab prince, of whom mention has been made in a former part of this Journal. The present governor is named El Hreidé Baka, but is not a Moor. The latter part of this information was not obtained from the Priest, but from various native travellers, whose statements fully corroborated each other: I shall only particularize Setafa, the messenger to Sierra Leone from Dalhaba, king of Sego; and Marmadé Jumé, a great itinerant, who came from the Mousi country only eighteen months ago; the latter in his answers to many questions which I put to him agreed, in many instances, with the accounts given by the sailor Adams, but he never heard of a headman named Woolloo, who, according to Adams, was king when he was residing there; he

has often met traders from Houssa, carrying salt, or congwa, to Timbuctoo. Congwa is used for many purposes; it is mixed with their food, is taken as a medicine, and is sometimes pounded and put into snuff; it has a bitter taste, and I should suppose is more like alum than salt. From the scarcity of this useful article the natives are often compelled to use as a substitute the ash procured by burning branches of the pullom, or cotton-tree. Setafa was at Janné about a year ago, and staid two moons; he relates the following curious circumstance regarding the purchase and payment of articles there, which, if correct, will shew that credit is given to no great extent in Janné. In the centre of the town there is a large market-place, where all merchandise and produce is, and must be, exposed to sale, any article disposed of otherwise being liable to confiscation; should any individual purchase goods from another, and be permitted by the seller to walk away without paying for them, he can never be seized upon for the debt, unless again found in the market-place.

In seven days from Janné, pursuing a south-westerly course, Mahomed Misrah reached Sego, the capital of the kingdom of Bambarrana, at which town I shall leave him to prosecute the remainder of his journey by himself, as this part of the country is already well known to us, through the medium of European travellers, and as it is to be presumed, that, before this time, an account, more circumstantial than any that has hitherto appeared, may have issued from the pen of Staff-surgeon Dochard, who passed several years in the interior, and a considerable length of time on the banks of the Niger; I nevertheless think it necessary to observe that I have in my possession the route of the Priest, as well as of many other natives, from Sego to the coast, and that although I am perfectly satisfied, from the agreement of the statements with other accounts, that the whole of Mahomed's information, as far as regards his own personal observation, may be relied on, yet I do not perceive any thing of sufficient consequence in the remainder to interest those who have already perused the travels of Mungo Park, Mollien, and others.

I put many questions to the Priest, respecting matters on which I was already well informed, to ascertain what degree of credit I might be authorized in attaching to his narrative; and I had much gratification in finding that the result proved to me that he was not only a man of strict veracity, but of intelligence, acuteness, and extraordinary correctness in his observations, for I frequently endeavoured, in the course of my several conversations, to confuse him, by altering the nature of the questions, but I generally found that his answers led to one conclusion only. After my first interview with him, I drew a map of his route from Pendy's large map of four feet square, and coloured it, to mark more distinctly the limits of the countries; at a second, I produced the map, which (as he understood it perfectly) enabled me to go over his journey with more precision than before*. He made several remarks on it, observing that the windings of the Nile were too numerous in Dongola; that Dar Bergoo was too confined, it being more than double the breadth from east to west; that the capital town of Bomors should be placed farther to the southward; that the river which falls into the lake Fitri takes its rise more to the northward and eastward; and that Kashara is a more considerable country than the map delineates.

The Priest supposes his day's journey might average about twenty miles, the whole giving a distance of 2720 miles, from Misrah to Sego, and as we know that Sego is about 700 miles distant from the colony of Sierra Leone, the whole extent of his journey may aggregate about 3620 miles, from which, if we deduct 400 miles completed for the deviation of the courses which he has himself given from the straight course between Misrah and Sego, 3020 miles will be left for the journey, had it been possible to perform it in a direct line; this at once exhibits a very extraordinary and satisfactory coincidence, for it will be found to differ but little from the straight measurement on the map, which is about 2925 miles. The attention is here naturally arrested to

* The accompanying chart, which I have copied exactly from Mahomed's own, may not be deemed superfluous, as it shews what idea he entertained of his course, having nothing to direct him but the sun. See Plate I.

admire the accuracy and astonishing capacity of this Priest, for had he travelled with an intention of marking his route, and been furnished with suitable instruments for the purpose, at the same time having a knowledge of the use of them, he could hardly have accounted for his ground more correctly, which is a very desirable fact to be certain of, as it enables us in conjunction with other circumstances already detailed, to attach a considerable share of importance to his information respecting the Niger. He appears to be quite positive that the Nile is a continuation of the Niger, and that Baher el Abeed is the link of connexion, for he has met people who have told him that they travelled along its banks, from Nufi to Sennaar; that it is very broad, and frequently overflows its banks, inundating the country to an immense extent. But while I attach little or no credit to what he has *heard* (being well aware that the native travellers too often consider themselves privileged to deal in the marvellous), yet I think, presuming the height which would be required for the source of the Niger not to be an objection, the only other is its great breadth at an early stage of its course, and the consequent magnitude which it would necessarily attain from tributary assistance, previous to falling in with the range of the Nile. But although a little very simple reasoning might in a measure cancel the latter objection, yet where there does exist one, let it be ever so trifling, the hypothesis cannot be allowed to be valid. It may be argued, for instance, that Mr. Park saw the Niger at Sego as broad as the Thames at Westminster, and many natives have assured me that, during the rains, it swells to such a size that the explosion from a musket cannot be heard on the opposite shore; towards Boussa, where Park lost his life, the river spreads out still wider, forming many considerable islands, but as it flows past Nufi, where the country is bold and mountainous, it becomes compressed within limits of about 400 yards; therefore, as the breadth of the Niger, nearly a thousand miles from its source, is only four hundred yards; and as the greater portion of the country through which it shapes its course is low and sandy, a cause to which it is indebted principally for its amazing breadth, we may infer that the

river is by no means of that magnitudinal importance which we have been led to suppose, and that the Niger may join the Nile, without making the latter a greater river than we have it already described by travellers. Mr. Bruce says, that the country about Sennaar, though flat, is nearly two miles above the level of the sea; from which, and from the northerly course of the Nile from that point, it must be clear that the slope of the land is towards the Mediteranean, and that if the Niger makes its way so far to the eastward, it must discharge itself into that sea, through the channel of the many-mouthed Nile. On the other hand, many natives from Houssa, who have been made prisoners by the Foulahs, and been brought overland to the Gold Coast, have affirmed that they crossed no mountains by the way, shewing that there is no barrier against the Joliba, or any other river flowing in that direction, but certainly not proving that it does; indeed, the easterly course of the Niger at Nufi, which has already been taken notice of, must in a great measure set that matter at rest; and if afterwards the Niger, from intervening high ground, is found to abandon its course eastward, and adopt a southerly one, the mouth of the Congo may be its outlet. How curious indeed, and how honourable to the memory of the immortal Park, should future research prove this to be the case.

It may not be out of place before I conclude, briefly to suggest a plan which appears to me more feasible than any that has as yet been proposed, for exploring the course and throwing light on the termination of the Niger. Some have recommended the hazardous undertaking of accompanying a caravan from the north of Africa, as the most likely means of ensuring success, while others have considered an attempt by way of the Senegal and Congo rivers more prudent, as well as more practicable; but as yet every trial has proved abortive, and it therefore behoves us to make our advances in a different manner.

The intercourse between the nations in the interior and the colony of Sierra Leone has of late years become very great, and, to a common observer residing in the colony, it must appear evident that the intercourse is daily increasing; indeed, to such an extent is good faith now established, that little excursions, in

the shape of parties of pleasure, are frequently made by the inhabitants among the neighbouring tribes.

Allowing that it is reasonable to expect, from the hitherto gradual enlargement of connexion, that the good understanding will be extended still farther by the just and equitable dealings of the merchants, as well as the liberal and philanthropic nature of this establishment, it can scarcely be considered a rash undertaking to set out as a travelling merchant from Sierra Leone, and keeping to the southward of Foulah Jalcon, reach Saukara, where there is little doubt that the English will be well known shortly; from Saukara a north-easterly direction ought to be pursued, to fall in with the Niger at Nufi, from whence its further course might be traced.

That this is the best route for arriving at such determination appears from the following consideration; the river will be reached much sooner, and with less hazard than if approached from the northward; and a short journey along its banks from Nufi might be expected to determine whether its course is bent to the south, or whether it firmly persists in its eastward direction.

It is advisable that this attempt should be made by a single traveller; and I trust, from the spirit of enterprise which has arisen in Sierra Leone, that the day is at no great distance when it will be undertaken with success. I am, Sir, &c.,

AN OFFICER IN THE ARMY
SERVING IN SIERRA LEONE.

Fort Thornton, April 10, 1821.

NOTES.

The town of Houssa is distant as far from the Niger, which is there called Lessee, as Port Logo is from Sierra Leone, or about sixty miles. It stands upon nearly a square mile of ground, is walled round, and has seventeen entrances or gates; the walls are about twenty-five feet in height, four feet in thickness, are very strong, though built of mud, and are defensible from the top, there being a path round the whole, about six feet from the summit. The houses are of a circular form, and are

thatched with grass, after the manner of those on the west coast of Africa; some of the streets are straight, and some winding. By digging two or three feet in the sand outside of Houssa, *water can always be procured*, but mud is no where to be met with in that country. The congwa is procured in Bornou, during the dries, from a place where water lodges to the depth of about nine inches in the rainy season; it is like fine flour, and lies from twelve to fifteen inches thick along the ground, from whence it exudes so profusely, that if a space of 200 yards is cleared in the afternoon, next morning at the spot as much may be gathered as will fill ten baskets. There is also a sort of red congwa, which is dug out of the ground in lumps, and tastes exactly like the white. It is bought in Bornou for fifty cowries an ass load, and sold in Goingia for 3,000.

[Collected from Serjeant Frazer, 2d West India regiment, who was born in Houssa, and resided there for a long time, was taken prisoner in Goingia, and brought to the Gold Coast, where he was sold.]

ART. II. *Extract of a Letter from* GEORGE POULETT SCROPE, Esq., *to* Mr. Brande, *respecting the Geology of the Paduan, Vicentine, and Veronese Territories.*

Dated Como, June 21, 1822.

On quitting Milan I took the direction of Venice; but was prevented by the early heat from residing for some time, as I had wished, in the Padovano, Vicentino, and Veronese. Several excursions, however, through these districts afforded me the opportunity of making a few interesting observations, some of which have never to my knowledge been made public.

I am not aware of the state of opinion prevailing amongst the English geologists of the present day, with respect to the traprocks of this country, whether their volcanic origin is disputed by any, or, like those of Auvergne, the Rhine, and western Italy, tacitly or openly acknowledged by all. The scientific writers of Italy also have long been strangely silent upon the geological facts presented by these regions. No one has

attempted any general account of them since Fortis, Strange, and Arduino. The Count Marzari Pencate has never published, and probably never put in order, the result of his researches on these points, which Brocchi, in the preface to his *Catalogo Ragionato*, hints to have been extensive. The cause of this silence is probably that little can be added to the accounts of Fortis, who in his last work, *Mémoires de Géologie*, published at Paris, 1802, satisfactorily proves these trap-rocks to owe their origin to the eruptions of submarine volcanoes; and I believe it myself impossible for any unprejudiced observer, with sufficient knowledge of the nature and characters of volcanic phenomena, to dissent from this opinion. These eruptions appear to have been confined to a broad band of country, extending from the southern flanks of the Monti Baldo and Gramulone to the neighbourhood of Monselice at the extremity of the Euganean hills. Whether this line is to be considered as an embranchment from the great trap district above, discovered by Marzari in the Tyrol, must depend on a similarity of constitution and position, which I have as yet had no opportunity to ascertain. The long and sloping ranges of sub-alpine hills which border the valleys of Ronca and Ciampo, as well as the two groups of the Monti Berici and Euganei, occupy this band; and I cannot but think it evident, that their peculiar situation, projecting like a series of promontories into the flat plain of the Po, and rising to a considerable elevation above its surface, is entirely to be attributed to the frequent mixture of trap rocks with the calcareous strata of which they chiefly consist, and the superior resistance they have, thus strengthened, been enabled to offer to the power which excavated, levelled, and paved with boulders the remainder of that immense valley.

In the trachyte (vulgarly called masegna) of the Euganean hills, I recognised the greatest general resemblance, and in many instances a complete identity with some of the trachytes of central France. The prevailing distinctions are, that the masegna sometimes contains quartz, and seldom or never augite, and exhibits a larger proportion of hornblende and

mica than the trachytes of the Mont D'or and Cantal. From an excess of these characters, it puts on in some situations the aspect rather of a primitive than a volcanic rock, and has thus been confounded by M. Da Rio, and, I believe, some other writers, with primitive porphyry; a classification from which one might imagine its often traversing as dykes, and occasionally surmounting strata of a secondary lime-stone, full of marine shells, would have ensured its exemption. But what absurdities are too gross to be resorted to as the last shifts of an expiring system? The masegna, like the French trachytes, is often accompanied by a trachytic breccia. It is frequently columnar. The nodular concretions it contains are remarkable, some being of pure quartz, others possessing the complete characters of hornblende rock, others of a granite, consisting of felspar, quartz, mica, and hornblende, in various proportions. The felspar is invariably of the glassy sort.

This variety of trachyte is the prevailing rock throughout the Euganean hills. In the Monti Berici, and the low ramifications of the Alps which descend towards these, an analogous position is occupied by varieties of basalt, containing imbedded crystals of hornblende and olivin, and occasionally some scaly grains of felspar. Augite is, as far as my observations go, entirely wanting. The basalt is frequently columnar, and engravings of the principal ranges in which this structure is conspicuous, may be seen in the works of Strange, Fortis, and Brieslak. It is generally accompanied by immense accumulations of a loose or indurated volcanic conglomerate, usually under the form of a peperino, and impregnated with calcareous or argillaceous particles.

What is chiefly remarkable in the trap of this district, is its being found indifferently both above and beneath strata of the old horizontal mountain limestone, which clothes the southern face of the Rhætian Alps, and is continued in the mountains of Istria and Dalmatia, and which also constitutes the mass of the Apennines. In the Valle Nera, near S. Pietro Massolino, I convinced myself of the accuracy of the observation made there by Strange, viz., the alternation of *ten* distinct beds of

basalt and limestone within a vertical depth of about 25 feet. The lowest, which forms the base of the mountain, is of limestone; the upper, constituting its summit, of basaltic peperino. The inner layers of basalt are of very little thickness, and may perhaps have been injected forcibly between strata of limestone, rather than the result of successive depositions. At the lines of contact both substances are intimately united by a partial intermixture of basaltic and calcareous particles. The basalt is occasionally hard and compact, sometimes highly porous, and of an earthy texture, approaching to wacke, and passing into a calcareous peperino; qualities which it apparently owes to the peculiar circumstances that accompanied its deposition. The same characters accompany all the trap-rocks of the Vicentine and Veronese, which vary at intervals from a basaltic breccia to a peperino, a wacke, and a dense crystalline and columnar basalt. All of these in turn contain amygdaloidal nodules of calcareous spar, chalcedony, semi-opal, mesotype, stilbite, analcime, and green earth.

But the most interesting point of the whole zone on which this rock shews itself, is the Purga di Bolca, so celebrated for the numerous fossil, fish, and algæ, contained between the laminæ of its bituminous limestone.

Two facts struck me, on visiting this spot, as not having yet, as far as I am aware, attracted the attention they are entitled to:—1. That the bituminous and fissile limestone of the Peschiera, or fish-quarry of Bolca, is merely a local variety of the horizontal mountain limestone, which constitutes the whole semicircular chain of mountains surrounding the Venetian plain. 2. That it obviously owes its peculiar characters to the effects of a volcanic eruption, bursting through the bottom of the ocean by which this limestone formation was deposited.

The two points on which alone fish are ever found, occur on the opposite flanks of a ragged and narrow ravine, and, in all probability, originally formed but one rock. Both are surmounted by a massive bed of peperino, traversed by huge veins of columnar basalt; and it is only immediately beneath this that the fish are found. At a very short depth below the

volcanic superstratum, the fissile limestone loses its extraordinary characters, and is replaced by the common limestone, with few or no organic remains, which forms the base and nucleus of this mountain, and the mass of those around. When, in addition to this, we recollect that the extraordinary attitudes of some of the Bolca fish prove them to have been enveloped in a calcareous sediment by some instantaneous catastrophe, it will be difficult not to conclude that they owe their death and wonderful preservation to some violent explosion of the sub-marine volcano, whose products overlie the very rock in which they occur.

The fishermen of Stromboli assured me, that after any unusually severe eruption of the volcano of their island, such as sometimes takes place in the stormy season, they have found the whole beach on one side of the island strewed with innumerable fish in a half-boiled state. The fossil fish of Bolca may be imagined to have perished in this manner, or rather to have been overwhelmed by thick clouds of loose, unconsolidated, calcareous sediment, cast up from the bottom of the sea by the volcanic explosions, and which subsiding quickly again, carried down the fish it had enveloped, and was in turn overwhelmed by the ejected lava. The heat, thus communicated, operating its sudden induration, was probably the cause of its highly fissile structure, as well as of the singularly perfect state of the imbedded fossils. The quantity of animal matter, afforded by the numerous fish thus enclosed, sufficiently accounts for the peculiar smell this stone gives out on friction.

It seems to me that the interest which has always been attached to the fish of Monte Bolca, from their excessive preservation, and the variety of their species, must assume a character of much deeper importance to the geologist on their being recognised as the inhabitants of that ancient ocean, which deposited the earliest secondary or horizontal limestone.

I observe that Brieslak, in a note to his *Institutions Géologiques*, § 533, mentions it to be the opinion of some naturalists, that the Bolca fish were enveloped in the ashes of a volcanic eruption; an opinion from which he justly dissents, on the ground of their being found in a bituminous limestone, which

bears none of the characters of a volcanic product. Who these naturalists are, whether such an hypothesis was in reality ever published, and in particular, whether it is thus fairly represented by Brieslak, I do not know; but his argument obviously cannot militate against the idea I have proposed above; viz., that the calcareous sediment by which the fish were enclosed was put in motion by the force of some volcanic explosion, then suddenly precipitated together with the objects it had enveloped, and almost as suddenly consolidated by the pressure and heat of the basalt and peperino deposited upon it. Perhaps the supposition which Brieslak refutes, originated in some confusion between the fish of Monte Bolca and the shells which at Montecchio and other points in the valleys of Ronca and Trissino, are occasionally found enveloped by a volcanic peperino, with a calcareous or argillaceous cement; a singularity of position which they evidently owe to having been caught up and invested by the puzzolana and ashes ejected by a subaqueous volcano.

Should the above remarks appear to you, my dear Sir, of any interest, you will oblige me by either inserting them in the next Number of the *Journal* of the Royal Institution, or as a note to any portion of the MS. I have forwarded to you, which they may serve to illustrate.

The opinion I have hazarded in those "observations" on the origin of the calcareous peperino which constitutes various isolated hills, rising from the plain of the Limagne d'Auvergne, has been very agreeably confirmed to me by all the observations I made on the similar rock occurring in the Vicentine and Veronese. The chief characters of both completely correspond, and the origin of each is evidently the same, with this only difference, that the eruptions which produced the peperino of North Italy, burst from the bottom of the ocean at the period of the deposition of the secondary limestone; those of Auvergne from beneath a fresh-water lake, possessing equally with that ocean the property of depositing a copious sediment of carbonate of lime, which in both cases is abundantly mixed with, and usually cements together, the volcanic fragments.

Art. III. *Conjectures respecting the Greek Fire of the Middle Ages. By* J. Mac Culloch, M.D. F.R.S., *&c.*

[Communicated by the Author.]

There are few of the inventions of former times that have excited more inquiry, and given rise to more discussions, than the celebrated Greek fire, so often used in the middle ages, in the wars of the Christians and Saracens. The subject is, in itself, sufficiently obscure; but it appears to have been rendered much more so, by many collateral causes, and most of all by that love of the marvellous in which the people loves to indulge. It seems pretty clear, that even grave historians are not exempt from this charge; and, in tracing their narratives and descriptions, the marks of exaggeration are not much less apparent than the confusion in which they have contrived to envelop this subject.

Among these historians, there are some who were witnesses to its effects, and some who even pretend to describe its composition. Yet to them we may turn in vain for distinctness, or truth. The actual terrors of some, the traditional ones of others, the exaggerated style of the times, and the general ignorance of science, have led to perplexities which it seems almost hopeless to try to disentangle. Succeeding antiquaries and historians, the analysts of all these barbarous histories, have had little better success; and after much vain toiling, the more prudent seem to have abandoned the inquiry in despair. Even Gibbon's gigantic hand, that seems to have wielded all subjects alike, whose mastery of the most abstruse, and the most perplexed parts of history appears perfectly marvellous, seems to have been compelled, like the rest, to yield.

Him we can excuse; while we may regret the want of that only knowledge, chemistry, which could have assisted him in the investigation, and which had he possessed it, would have left nothing for his successors to do. The same excuse will hold good for Du Cange, Des Brosses, and others; perhaps for Dutens also. Grose might have done more than he has,

for he knew much of what was required for its illustration. Watson, better fitted still for the inquiry, has shunned it entirely, after leading us to hope that he was about to enter on it.

It would be presumptuous to expect to render that clear which so many great names have thus attempted in vain, or abandoned as hopeless. Yet by comparing the narratives and descriptions of the ancient writers with each other, and with some collateral information, that can be brought to bear on the same point, it will not be very difficult to make some steps at least on firm ground. It will turn out, unless I am much mistaken, that different inventions have been described by the same name, and that the main source of the confusion can be traced to this cause. It may perhaps even appear, that though we cannot in this way reconcile all the accounts, yet that we shall discover what some kinds of the Greek fire really were, if we should still remain at a loss about others. Something too will be gained by divesting these accounts of the marvellous, which has in no small degree aided their confusion in obscuring this provoking subject.

In examining this question, it will, I think, appear that some of the inventions which we consider modern, are of a very distant date; and that if we have so long remained ignorant of that, it is because there is scarcely a scientific writer of those ages to which alone we must look for this kind of information. It will also be seen, that there is an intimate connexion between the history of the Greek fire and that of gunpowder. But it is here intended to avoid touching on that subject as much as is possible, and to reserve it for a future communication.

The common opinion is, that the Greek fire was invented during the reign of Constantine Pogonatus, in the year 668, by Callinicus, an architect of Heliopolis. Gibbon has collected another tale, which says that it was revealed to Constantine the Great by an angel, with a sacred injunction that this gift of heaven and peculiar blessing of the Romans, should never be communicated to any foreign nation. The impious attempt, it was said, would provoke the sudden and supernatural vengeance of the God of the Christians.

Thus, he goes on to say, it was confined for four hundred years to the eastern Romans; adding, that at the end of the eleventh century, the Pisans suffered from it without knowing its composition. He concludes with saying, that it was at length either discovered or stolen by the Mahometans; and that in the holy wars of Syria and Egypt they retorted an invention, contrived against themselves, on the heads of the Christians. I think it will appear presently, that Gibbon has not examined this subject with his usual acuteness, and that he is here decidedly wrong as to the history of the invention and its true progress.

We know not, indeed, why this great historian should have formed the judgment which he has done on the invention of gunpowder; since his reading must, if any person's could, have led him to a different conclusion. He says, "Vanity or envy has tempted some moderns to carry gunpowder up to a period beyond the fourteenth, and Greek fire before the seventh century." What the motives of the writers with whom he thus disagrees might have been, it is unnecessary to ask. Dutens has experienced some harder blows than this; yet that the historian is himself in the wrong here, it will not, I believe, be very difficult to show. I must defer the question of gunpowder, as long as possible, and be content with inquiring what probability there is that the Greek fire was a Greek invention at all; and whether it is not much more probable, that the Greeks, or eastern Romans, borrowed it from the oriental nations, instead of teaching it to them.

We may safely begin by putting aside the history of the angel and Constantine the Great, though willing to believe that it might have been known before the time of Constantine Pogonatus. It will be better to take up the story from Callinicus, as it carries with it more of the appearance of circumstantiality and truth.

The communication between Heliopolis and the eastern nations, renders it, in the first place, suspicious, that the Greek architect borrowed the invention from the orientals. That they possessed it at least before the Greeks, whether they commu-

nicated it or not, appears to me as capable of proof as can be expected under similar circumstances. When Gibbon says that the Mahometans borrowed the invention from the Christians during the wars of the crusades, he forgets that the Arabians learned their chemistry from the Egyptians, by whom that art was practised three hundred years at least before the time of Mahomet. That they also borrowed from a still more distant oriental source, appears equally certain.

But to return to the supposed invention of Callinicus: naphtha is said to have been one of the chief ingredients in this composition. This substance is well known to be very common in many parts of the ancient Persian kingdom and in India; near the Caspian sea it occurs over an extensive tract of country. It arises out of the ground in the form of vapour or otherwise, in such abundance as to be commonly used for domestic purposes; it was also an object of religious attention to the worshippers of fire. It is noticed, among other authors, by Judas Maccabæus, or rather by the compiler of that history.

Now it is much more probable, that a burning compound in which this was an ingredient, should have been invented where the substance abounded, than where it was unknown. The latter is barely possible, but far from likely; and if it can be proved, that the use of inflammable compositions in war or otherwise, was known to the eastern nations before the time of Callinicus, his claim to this invention falls to the ground.

The Arabian claims of a more modern date are already excluded; nor can these people, at any former period, have a title to the discovery, if it can be shewn that its source lies further to the eastward. There seems little reason to doubt that all the Arabian learning, as well as their algebra, had its origin in India; the parent it is probable of Egypt itself, and the great ancient source of all art and science.

The true nature of this composition, or rather of these inventions, (for it will be seen that there are more than one,) will be examined hereafter. In the mean time it is necessary to remark, that the same effects have been attributed to different contri-

vances, before asking what claims India has on any of them. It is not surprising, if, when these burning compositions, whatever they may have been, were new and little known, they should have given rise to so many tales, and as is more than probable, to much exaggeration. Had the Mexicans given the history of the Spanish arms, and had no other history of guns and gunpowder come down to us, it is easy to understand what the consequences must have been.

It is not here however meant to be denied, that this invention might have spread among the later Arabians from the Greeks. Notwithstanding the attempts at secrecy, the consequence of an order of Constantine Pogonatus, it is certain that it did spread among the surrounding nations, as is fully recorded in the histories of those days. It became common, and probably from this very source, in the wars of the crusades. But it is also possible, that this, or one of the different inventions known by the same name, might have been discovered by the Arabians themselves, who were then much addicted to chemical pursuits. This confusion arises from that just noticed, which includes more inventions than one under the common term Greek fire.

We shall hereafter see that one at least of the Greek fires of the crusades was a composition into which nitre entered, and therefore depending on the same principle as gunpowder. Thus the two inventions are connected; although it will appear that gunpowder, used as a projectile force for shot, is the more modern of the two. Pyrotechny, or the art of making fire-works, appears to be the original invention, and to have been the true parent of gunpowder, ancient as well as modern. It will be soon shewn, how the Greek fire described by Joinville as used at the siege of Acre, agrees with the most ancient record we have of the use of a similar invention in India.

Like printing, the loadstone, and much more of our knowledge that is little suspected, there seems abundant reason to suppose that the cradle of pyrotechny was in the east. In China, the use of fire-works for amusement has been known from a period beyond all record; and, in India, the use of rockets for military purposes is of an antiquity equally obscure. As all

pyrotechny depends on the property which nitre possesses of accelerating or determining the combustion of inflammable substances, even when these are excluded from the air, and as all the compositions used in this art bear an analogy to gunpowder, it is plain, that the antiquity of gunpowder is implied in that of pyrotechny. Yet it is probable, as before suggested, that the art of making fire-works by means of nitre and inflammable substances, is of more ancient date than that of making gunpowder as we now know it. The one can, in fact, be done in a certain way, by almost any mixture of combustible substances into which nitre enters in a sufficient proportion; whereas duly to select the proper combustibles, to proportion the ingredients, to mix and to granulate them, requires a degree of contrivance, attention and practice, which was not likely to have occurred till long after. It is even probable, that ordnance was derived from some kind of fire-works; it was much more likely at least to have originated in this manner, than from Barthold Schwartz's mortar; a fable so often repeated as to have become a matter of general belief.

Without therefore thinking it necessary to examine the question of gunpowder particularly, which is in itself but a branch of pyrotechny, I may attempt to trace backwards to the oldest records that have come down to us respecting any compositions of this nature. These, as already observed, lead us to India; and if any hesitation is felt in allowing to the oriental nations, from a time so remote, an art which only reached us long after, we must recollect, that astronomy and algebra were known in India equally long before they had found their way into Europe. The latter, in particular, is of very recent introduction. In the same manner were printing and the mariner's compass known to the Chinese, long before they had been introduced among the western nations, although both of them were inventions fully as likely to have spread. If we are inclined to ask why the messengers of Justinian, who brought silk from that remote empire into the west, did not also bring gunpowder and fire-works, we must also explain why they did not bring the art of

printing; an invention far more likely to have attracted and excited the attention of a literary people.

In Grey's *Gunnery*, printed in London in 1731, the following passage is found, deduced from the life of Apollonius Tyanæus, by Philostratus. "These truly wise men dwell between the Hyphasis and the Ganges; their country Alexander never entered; deterred, not by fear of the inhabitants, but, as I suppose, by religious considerations: for had he passed the Hyphasis, he might doubtless have made himself master of the country all round; but these cities he never could have taken, though he had led a thousand as brave as Achilles, or three thousand such as Ajax, to the assault; for they come not out to the field to fight those who attack them; but these holy men, beloved by the gods, overthrow their enemies with tempests and thunderbolts shot from their walls. It is said, that the Egyptian Hercules and Bacchus, when they over-ran India, invaded this people also, and having prepared warlike engines, attempted to conquer them; they, in the mean time, made no shew of resistance, appearing perfectly quiet and secure; but upon the enemy's near approach, they were repulsed with lightning and thunderbolts hurled on them from above." These people were the Oxydracæ, and the period of Alexander is 355 years before the Christian era.

Here then is a record of the very early use of some kind of fire-work; whether of ordnance, is more doubtful. It is more probable that this story alludes to some kind of rocket, the very rocket of modern India, perhaps, which would fulfil the condition both of lightning and thunderbolts.

This strange history of the Oxydracæ will render more easy of belief that which is related of the use of gunpowder, and even of ordnance in China, at a very early period; a time no less distant than 85 years after the birth of Christ; and an invention which, if admitted, would, as already suggested, prove the much earlier knowledge of the less difficult kinds of pyrotechny.

If there is somewhat of the air of fable in this story of the Oxydracæ, its probability is confirmed by the very early know-

ledge of explosive compounds in the east. Even gunpowder is mentioned in the code of Hindoo laws; and that code is, by oriental antiquaries, supposed to reach back to the time of Moses. It may also be added, that there is a passage in Quintus Curtius, where a compound possessed of these qualities is mentioned, strongly confirming these testimonies.

If this is thus far right, the claims of the early orientals to the Greek fire is established. The Greeks might have received it from the Arabians, or from a more direct source; but it seems likely that Western Europe, at least, is indebted to this people for its knowledge of pyrotechny. It will be useful to shew that this art is of more ancient date among us than is commonly imagined.

I quote through Hallam. An Arabian writer in the Escurial Collection, about the year 1249, as translated by Casiri, has the following passage: "Serpunt susurrantque scorpiones circumligati ac pulvere nitrato incensi, unde explosi fulgurant atque incendunt. Jam videre erat manganum excussum veluti nubem per aëra extendi, ac tonitrus instar horrendum edere fragorem, ignemque undequaque vomens, omnia dirumpere, incendere, in cineres redigere." This appears to be the description of a rocket, and does not much disagree with Joinville's account of the Greek fire at Acre.

We may puzzle ourselves, indeed, somewhat between a rocket and a shell, or carcass; yet this would make no difference as far as relates to the question of the Greek fire. The "serpunt," the "susurrant," and the "circumligati," apply best to the description of the former. But the use of the "manganum," from which our early engine, the mangonel, derives its name, bespeaks a mechanical force which could not have been required for a rocket, and which is moreover not very easy of application. We might almost also conclude that this was a shell, from the effects: "omnia dirumpere, incendere, in cineres redigere," applies rather to this machine than to a rocket, unless indeed these were contrived, like the Congreve rockets, to carry a shell with them. There is exactly the same difficulty in Joinville's account of his Greek fire, as will appear hereafter.

The next authority is decisive, respecting the rocket, and it is found in a manuscript quoted by Dutens, from which Roger Bacon is supposed to have derived his knowledge of fireworks. The author's name is Marcus Græcus, and, by the title, the work appears to be a general essay on military pyrotechny.

"Incipit liber ignium a Marco Græco perscriptus, cujus virtus et efficacia est ad comburendum hostes, tam in mare quam in terrâ." The directions for making a rocket are as follows: "Secundus modus, ignis volatilis hoc modo conficitur. R. libras duas sulphuris vivi, libras duas carbonis salicis, salis petrosi libras sex: quæ tria subtilissime terantur in lapide marmoria; postea pulvis ad libitum in tunica reponatur volatili vel tonitrum facientia. Nota, quod tunica ad volandum debet esse gracilis et longa, et prædicto pulvere optime calcato repleta: tunica vel tonitrum faciens debet esse brevis, grossa, et prædicto pulvere semiplena et ab utraque parte filo fortissimo bene ligata. Nota, quod in qualibet tunica primum foramen faciendum est, ut tenta imposita accendatur; quæ tenta in extremitatibus fit gracilis, in medio vero lata, et prædicto pulvere repleta. Nota, quæ ad volandum tunica plicaturas ad libitum habere potest, tonitrum vero faciens quam plurimas plicaturas. Nota, quod duplex poteris facere tonitrum, ac duplex volatile instrumentum, vel tunicam subtiliter in tunica includendo."

There is here no direction, it is true, for boring a rocket, without which it cannot fly by its own recoil; so that it is possible this firework may be a kind of squib, intended to be rendered "volatile" by mechanical means, and not by its own unassisted energy. It is not unlikely that this is the very fire of Joinville; and the distinction into two parts, the "tunica volatilis," and the "tonitrum faciens," confirms the opinion that these ancient projectiles combined the nature of a shell and a rocket together.

It is unnecessary to trace this invention further down. Bacon is the mere copyist of Marcus Græcus, or more probably the recorder of a composition in common use. But the extent of his claims, and of the still worse founded ones of Schwartz, may be suffered to remain for a future notice on gunpowder.

Having thus traced the origin and progress of pyrotechny as far as the evidence admits, it is time to return to the more particular consideration of the Greek fire, and to try to ascertain, from the narratives of authors, if possible, what its nature and effects really were.

It seems clear that no single invention, or composition, of a combustible nature, will fulfil all the conditions of this celebrated military firework. It is easy enough to conceive how those who felt the alarm and the effects, and knew not the means, should have confounded all these annoying contrivances under one term; or it is possible enough that they might have given this as a generic name to all offensive fireworks, while their readers, ignorant of the subject, have imagined that the composition was as single as the name. It will presently be seen, by the description of a few of the effects recorded by writers and eye-witnesses, what probability there is in this supposition.

Having traced generally the origin of pyrotechny from the East, it will however first be proper to see if some of the particular inflammable compounds, known by the name of the Greek fire, cannot be traced thither also. It is reported by the author of the *Esprit des Croissades*, to have been known in China in the year 917. This, it is true, is 250 years after the time of Constantine Pogonatus; yet as the Chinese have never been known to borrow arts from the Europeans, it is far more likely that it was known to them long before. This is a supposition, indeed, that can scarcely be rejected, if, as already shewn, the eastern nations, and the Chinese among the rest, were acquainted with the properly explosive compounds, or with gunpowder. The same reporter says, that it was there known by the name of the Oil of the Cruel Fire, and that it had been introduced by the Kitan Tartars, who had learnt the composition from the king of Ou. Thus the oily or resinous Greek fire, which forms one of the kinds immediately to be described, seems to claim an oriental origin as well as the explosive and combustible nitrous compounds.

With respect to the names, composition, and effects of the Greek fire, the Byzantine writers are our earliest European au-

thorities; and, unfortunately, these personages are all very prone to the marvellous.

The Greeks called it the liquid, or maritime fire, probably from its application in naval engagements, as it is certain that they were acquainted with the use of fireships. Procopius, in his history of the Goths, uses the same term as the Chinese, calling it an oil, Media's oil, as if it had been some infernal composition of that noted sorceress. But the historian seems to have borrowed this term from Pliny, who calls naphtha ελαιον Μηδειας, a sort of proof, by the way, that naphtha entered into its composition. Cinnamus also calls the Greek fire πυρ Μηδικον. All these names bespeak some resinous or oily inflammable compound, such as might be used in fire-ships, or for other purposes, without the intervention or help of nitre. But Leo uses a different mode of expression, when he calls it πυρ μετα βροντης και καπνου. We must conclude that he is speaking of some explosive substance into which nitre entered as an ingredient, and that there were consequently more Greek fires than one. Of the terms used by others, I need only notice that of the author of the *Gesta Dei per Francos*, who calls naphtha *oleum incendarium*, making it further probable that this ingredient entered into some of these compounds.

With respect to its composition, the information is very scanty; but the descriptions seem all to refer to resinous and oily substances, confirming the opinion to be derived from the greater number of the names above recited. By some it is said to have been unctuous and viscid, while others again describe it as a solid substance. Quintus Curtius considers it as made of turpentine. Anna Comnena says that it was composed of sulphur, bitumen and naphtha. In another place she says that it was a mixture of pitch and other similar resins, and that it was thrown from balistæ, and attached to arrows.

Other authors also describe the modes in which it was used. In fire-ships it was blown through tubes over the sides. This is not very intelligible, unless it refers to ordnance of some kind, which we can scarcely admit. Fire-ships of this kind were

sed by the Arabs, at the second siege of Constantinople, in 16 and 718. In other cases it was poured from the ramparts large boilers; a description which agrees very well with a merely inflammable resinous composition. Tow was dipped in it, and wrapped round arrows, a mode of use that will apply to the same class of compositions. But it was also launched in red hot balls of stone or iron. There we are at a loss again. This could be no mode of using a resinous composition, and it is more likely that these balls were some kind of carcasses, or hollow bodies, projected by means of balistæ, or other machinery. In this case the composition must have contained nitre, as without that no resinous compound could have burnt in such confinement, without access of air.

This leads to the conclusion formerly made, that there was more than one kind of Greek fire, or that different kinds of military fire-works were described under a common name. It proves, perhaps, still more; namely, that the reporters were ignorant of its nature, and that they named by guess those substances with the inflammable properties of which they happened to be acquainted.

It is now time to try to reconcile the more particular reports of its effects, and of the manner in which it was used, to any of the compositions above-named, or to any single invention. The description in the *Speculum Regale*, from a manuscript of the thirteenth century, is amongst the least intelligible. After enumerating several military engines, it says, "Omnium autem quæ enumeravimus armorum et machinarum, præstantissimus est mentvus clypeorum gigas, flammas venenatas eructans." Of this I must fairly confess that I can make nothing.

The next account that I may select is from a French Chronicle of 1190, by which it would appear that it was a liquid, enclosed in vessels of some kind, "phioles." Here is the passage itself: "Ainsi qu'il alloit par mer il rencontre un nef de Saracens que le Soudan Saladin envoioit en Acre pour le secours faire à ceux, qui étoient en la cité, et cette nef avoit grande plant de phioles de voire pleines de feu Gregois."

This was then the liquid fire that is said to have been used by hand at sea, or in close action, and which is also said to have been thrown by means of military engines, in sieges. It is evident that this is not Anna Comnena's fire, as that could not well be thrown from balistæ, or attached to arrows; unless we imagine that it was always used with tow, as before mentioned. Hers appears rather to have been a solid composition. It dis-agrees still more with that of Leo and Joinville.

It is not very easy to conjecture what it really was. Supposing it to be naphtha, or petroleum, or any similar liquid, it is certain that it could not have been thrown from any machinery in a stream to any distance, as it must have been extinguished in its passage through the air. As little could it have been used by hand to produce any serious effect, or not at least without the risk of equally injuring both parties. On the other hand, it could not have been thrown in an inflamed state in these "phioles," or in any other close vessels, as it could not have burnt without the contact of air.

It is idle to say that the Arabs or Greeks of that day had chemical substances unknown to us; and as it is impossible to reconcile this description to any imaginable composition or effects, the point must fairly be given up as unintelligible. We cannot suppose the liquid in the "phioles" to have contained nitre, because that salt will not mix with any liquid of this nature in such a manner as to aid its combustion.

Whatever this was, it has at any rate been shewn that it was but one of many military fires, and that it must not be taken as the standard of the "feu Gregois."

It is worth while, however, to quote the opinions of the times respecting it, as it seems to have inspired an unreasonable degree of terror. We cannot suppose that it ever was in very common use, as many authors who have described the military operations of these times, and among the rest, William of Tyre, take no notice of it, though in his account of the sieges and actions which he relates, assaults and defences by ordinary fire are frequently mentioned. The romancers of these ages, the

abstracts and brief chronicles of the times, are equally silent respecting it. The pagans have all the credit of it, at least in the following verses:

> Ignis hic conficitur tantum per Paganos
> Ignis hic exterminat tantum Christianos
> Incantatus namque est per illos prophanos
> Ab hoc perpetuò, Christe, libera nos.

The good monk seems to have held it in great horror.

The descriptions which represent it as unctuous and viscid, and as adhering to the objects which it reached, may be perhaps reconciled to the former, since a viscid substance, as well as a liquid one, might have been kept in "phioles." But as these viscid and unctuous substances only present the same kind of difficulties as the former, I need not dwell on them. They might easily have been all formed of the same resinous ingredients in various proportions.

There is a much greater difficulty coming. The opinion of the Greek fire being inextinguishable by water, could not justly have been entertained of any compositions of this nature, not even of Anna Comnena's sulphureous compound. No burning substance could have resisted an application of this nature, provided it were employed in sufficient quantity, unless under the protection of a carcass or tube of some kind, in which case it must also have contained nitre. It is plain that there is either a good deal of imagination or of ignorance in these reports; such, indeed, as to throw serious doubts upon much more of the history of this substance. The Florentine monk, who describes the siege of Acre, says,

> Pereat ô utinam ignis hujus vena
> Non enim extinguitur aqua sed arena
> Vixque vinum acidum arctat ejus fræna
> Et urina stringitur ejus vix habena.

That sand should have extinguished some of these fires, we can understand; but that it should have been put out by vinegar and urine, and not by water, is impossible, as these were not likely to have been procured in sufficient quantity, surely not in such abundance as water; and on no other principle could the one have acted better than the other.

I do not see that any further light can be thrown on these varieties of the Greek fire. The accounts seem to be confused, and unintelligible, as far as they are so, partly by the ignorance, and partly by the exaggeration, of the reporters. Abstracting these, it is probable that they were truly enough, as has been said, resinous inflammable compounds, solid, tenacious, or liquid, without nitre, and exactly similar to the fires of our own ancient fire-ships, before chemistry had taught us to proceed on better principles. Fire arrows have been used by nations who never heard of Saracens or Greek fires. If there is any thing further to be explained, it appears to have arisen from applying generally to all these military fire-works the effects of some of them, an error easily produced by the use of a general term. Joinville's fire will probably help to explain the mystery, such as it is.

His description will be found much more intelligible, and will, I think, fully prove the supposition that there were different things known by one name, and that the Greek fire used against Louis at Acre was neither the Chinese oil, nor any oil, nor any viscid substance, nor even the composition described by our celebrated female historian. As this writer was an eye-witness, having been himself present at this famous siege, his account is as worthy of credit as it is clear and descriptive. We shall also have reason to see that it implies a knowledge of gunpowder, and possibly even of ordnance, and that the former invention is thus carried back to a period which supports the account of the Arabian author of 1249, who has been quoted from Casiri.

According to Joinville, the Greek fire was thrown from the walls of Acre by a machine called a petrary, occasioning such terrors among the commanders of St. Louis's army, that Gaultier de Cariel, an experienced and valiant knight, advised his men, as often as it was thrown, to fall prostrate on their elbows and knees, and pray to God, as he alone could deliver them from the danger. And as the king lay in bed, whenever he was informed that this fire was thrown, he used to raise himself, and, lifting his hands, exclaimed, " Good Lord, preserve my

people!" This petrary only threw it three times in the night, but it was also thrown four times from a cross-bow.

Here we have apparently two kinds of artillery; since, as it is described to have come from "the bottom of the petrary," that machine can scarcely have been any thing but a piece of ordnance; a mortar, perhaps, of large bore. The cross-bow, or balista, might have been used for the same purpose for a smaller projectile of the same nature, or possibly for some other kind of fire.

To confirm the opinion already given of the nature of the fire which thus annoyed St. Louis, it must be remarked, that it came forward as large as a barrel of verjuice, with a tail issuing from it as big as a great sword; making a noise in its passage like thunder, and seeming like a dragon flying through the air; while, from the great quantity of fire which it threw out, it gave such a light that one might see in the camp as if it had been day.

Now we are here still left to our conjectures as to the exact nature of this fire; as we have no other account of it than that of Geoffrey de Vinesauf, who attended Richard to the crusade, and who describes it as consuming even flint and iron, and as being unextinguishable by water, while it was also attended by a pernicious stench and a livid flame.

It is apparent, on considering this evidence, that the fire now under review bore no relation to those which were first described, and that we have to choose between a rocket and a carcass. There are difficulties both ways. The fact of its having been projected from a petrary, is in favour of a carcass; as a rocket would not have borne the explosion of a piece of ordnance, and which indeed could not have been necessary, since it is capable of flying by its own energy. As little could a cross-bow be required for a rocket; while small carcasses, or inflamed balls, like our modern light-balls, of a firm texture, might easily have been projected in this manner.

On the other hand, though the fuse of a carcass would produce a tail of light, that would not have been equal to a long sword, nor could it have illuminated the whole camp. This is

more like the description of the stream of fire from a rocket; while the noise like thunder, which attended its passage, agrees well with the latter machine, but not at all with a carcass, which only makes a gentle whistling as it passes through the air. Thus it may be supposed that it must have been a rocket; an opinion, perhaps, supported by the early knowledge, formerly discussed, of this projectile, in India, whence, as I have already attempted to shew, the Arabians derived this invention, among much more of their knowledge.

The only objection to this notion, is the fact of its having been projected from some machine, as just mentioned. But this may be obviated by supposing that it was a firework of this nature, without a bore, and therefore incapable of flying by its own recoil: in short, a huge squib. Such a firework as this would produce all the appearances described; the long tail of fire, the noise, and the light; and it would require a projectile force, which might have been given both by mechanical and chemical artillery, by the balista, and by the petrary or mortar. This opinion is further confirmed by the description of the rocket in Marcus Græcus, which seems also to have been a military firework. There are no directions for boring it: whereas, had that been practised, it was scarcely possible he should have omitted to mention it, minute as he is in all his description of the composition, and of the two cases, the "volatile" one and the "tonitrum faciens." Indeed, he positively directs the rocket-case to be completely filled and well rammed. It is scarcely necessary to say, that an unbored rocket cannot fly without a foreign projectile impulse.

If I am thus right in supposing the Greek fire of Joinville to have been a rocket of this imperfect kind, it is easy to explain the resistance which it offered to any attempts to extinguish it. Water has no effect, because the blast from the orifice prevents it from entering; for the vinegar and urine, the good monk must be held responsible. It is pretty clear that his account of this property in the Greek fire has been derived from these very fireworks, and has, by the usual mistake, been assigned to the whole race.

Whatever this formidable fire was, it seems to have caused more alarm than injury, as we cannot discover in the narration, that any mischief of moment was produced by it. This is pretty much the case with rockets at the present day.

I may yet remark on Joinville's history of this siege, that, while it confirms the opinion before held out of the differences in kind among the Greek fires, and of the real nature of this particular one, it also corroborates that which has already considered the Arabians as acquainted, even at that distant time, with the explosive compounds that derive their properties from nitre.

If it was a rocket or a squib, that admits of no doubt; if it was any kind of carcass, or fire-ball, the same is true; as no resinous compound, without nitre, could have burnt enclosed in a case, as this appears most evidently to have been; and as indeed no such compound at liberty could have resisted water. Nitre is absolutely necessary for every kind of carcass, and that in considerable proportion: and it is only indeed by compounding the charge of carcasses on the same general principles as gunpowder, that they can be made effectual.

As no further light can be thrown on this subject from the ancient authors, it is unnecessary to prolong this inquiry. The subject seems to be cleared, at least, of much of its mystery; and that this mystery has in a great measure arisen from mistakes and exaggerations, must be very apparent. We may remain at our ease on this head, and be satisfied that we have lost nothing by our imaginary loss of the Greek fire. We may still safely boast, that in whatever arts either the Greeks or Arabs may have excelled us, in that of destroying each other we could have taught them much, and could have learnt nothing from them. Divested of the mist which wonder and ignorance have drawn round it, the boasted Greek fire seems to have been a contemptible weapon enough. Had the rhyming monk or St. Louis been at the sieges of Copenhagen or Algiers, it would be difficult to conjecture where they would have found words to express what must have been, to their fires, like the thunders and lightnings of heaven to those of the theatre.

It will not be misplaced to bestow a few words more in bringing down the use of this engine of war to a later period. We already hinted that, about the end of the eleventh century; the eastern Romans used it against the Pisans, at which period the secret of its composition was unknown, not only to the sufferers themselves, but to western Europe. But we are informed by Père Daniel, that Philip Augustus brought some from Acre, and used it against the English vessels at the siege of Dieppe. Lastly, when Ypres was besieged by the Bishop of Norwich in 1383, the garrison defended itself with Greek fire. At this time gunpowder and ordnance had become common, and from that period the very term Greek fire fell into disuse.

Since that, however, there have not been wanting inventors who have laboured to discover what required no discovery; dazzled by the visionary character of this exaggerated and mysterious substance. Neither have there been wanting quacks and impostors, who have pretended to a knowledge of the imaginary secret from interested views. Grose informs us that a chemist in this country, whose name, however, appears to have been forgotten, pretended to this piece of knowledge, and enjoyed an annual pension on condition of keeping it secret, because our government was unwilling to increase the destruction and cruelty of war. The same attempts were frequently made by this fruitful race during the late war, but not with the same success. In France also, many years ago, a certain Dupré received a pension on the same grounds. But the world has grown wiser of late; and we are in little danger now of being misled by any modern empiric, however we may still choose to dream over the tales of the careless and credulous Byzantine writers.

Art. IV. *An Account of some Observations made with Mr. Daniell's Hygrometer, in Brazil, and on the Equator, by* Alexander Caldcleugh, Esq.

[Communicated by the Author.]

On my return from the southward to Rio de Janeiro, the end of July, 1821, I was extremely pleased to find one of Mr. Daniell's Hygrometers among some other instruments Mr. Newman had sent out; and although from the general dryness of that period of the year, experiments on the quantity of humidity contained in the air were not likely to prove the most interesting, yet I did not consider either this circumstance, or the probable shortness of my stay, as affording a sufficient excuse for leaving the country without making some observations; and these, imperfect as they are, I have now the honour of laying before the readers of this Journal.

I shall take the liberty, however, of prefacing them with a few general remarks on the climate of this part of Brazil.

The summer begins about the months of October or November, and lasts until March or April. This is the wet season, but the rains by no means descend from morning till night, as in some other tropical countries, but commence, generally, every afternoon about four or five o'clock with a thunderstorm. The heaviness of the rain can only be conceived by those who have been in these latitudes. This fall naturally arrests the sea breeze, and the succeeding night is dark and cloudy. Formerly these diurnal rains came on with such regularity that it was usual, in forming parties of pleasure, to arrange whether they should take place before or after the storm. During this period of the year there is seldom, if ever, a deposition of dew.

From April until September very little rain falls: vegetation almost stops, and to the eye of every one who has not just arrived from Europe a wintery appearance is discernible. The land and sea breezes do not succeed each other with the same regularity, and are besides more frequently disturbed by violent gusts from the S. W., imagined to be the tails of those destructive winds the Pamperos of the River Plate. The nights are beautifully clear; Venus casts a shadow, and the southern constellations are seen in all their beauty. The dews, as might be expected, are at this season very copious. The annual mean height of the barometer in Rio de Janeiro is about 30.275, and of the thermometer a fraction above 73° Fahrenheit.

METEOROLOGICAL JOURNAL, commencing at Rio de Janeiro, 1st August, 1821, and continued on the Route to Villa Rica.

Day of the Month	Locality.	Face of the Country.	Barometer noon	Thermometer Attd.	Thermometer Detd.	Dew Point	Difference	Weight Vapor in Grs. in Cubic foot	REMARKS. Observations at 12 o'Clock when not otherwise expressed.
1	Rio de Janeiro	The Country about Rio abounds in coneshaped hills clothed to their summits with wood.	The state of the Barometer was not recorded during this period.		71	60	11	5.650	Fine.
2	"				70½	59	11½	5.467	Fine.
3	"				71	62	9	6.029	Fine, a little cloudy.
4	"				69	58	11	5.293	Fine.
5	"				70	56	14	4.939	Fine, regular breezes.
6	"				72	55	17	4.756	Fine.
7	"				73	57	16	5.080	Fine.
8	"				73	56	17	4.909	Fine.
9	"				72	57	15	5.089	Fine.
10	"				72½	55	17½	4.756	Fine.
11	"				72	55	17	4.756	Fine.
12	"				72½	56	16½	4.918	Fine.
13	"				73	58	15	5.251	Fine.
14	"				73½	57	16½	5.080	Fine.
15	"				73	59	14	5.434	Fine.
16	"				74	59	15	5.425	Fine.
17	"				74	58	16	5.242	Fine.
18	"				73	60	13	5.625	Fine.
19	"				75	62	13	5.982	Fine—Late sea breeze
20	"				74	63	11	6.184	Fine.
21	"				74½	60	14½	5.616	Fine.
22	"				74	57	17	5.070	Fine.
23	"				77	69	8	7.430	Late sea breeze—Rain at night
24	"				73	66	7	6.824	Fine.
25	"				74	64	10	6.387	Fine.
26	"				75	65	10	6.493	Fine.
27	"				75	67	8	6.909	Fine.
28	"				79	74	5	8.715	Warm, heavy rain at night.
29	"				74	68	6	7.233	Rainy in squalls.
30	Left Rio de Janeiro		29.753	75	76	65	11	6.482	Fine, but sultry and cloudy.
31	Porto d'Estrella	Swampy.	29.801	75	75	62	13	5.982	Gloomy, heavy rain at night.
Sep. 1	Mandioca		29.651	71	70	60	10	5.660	Fine, thunder storm.
"	Pass of the Organ Mountains		27.152	67	68	61	7	5.877	Slight rain, 1 80th.
2	Padre Correa		27.752	66	65	57	8	5.156	Gloomy, 7 A. M.
3	Pampulha	tainous and ded.	28.152	68½	67½	58	9	5.303	Gloomy morning.
4	Three leagues in advance		29.250	68	66	54	12	4.664	Fine, most oppressive sun.
"	Over the Valley of the Paraiba		28.202	80½	80	75	5	9.013	Noon observation.
"	Bank of the Paraibuna		29.902	78	78½	72	6½	8.184	Evening—Temperature of the river 71°.

5	”	Extremely moun thickly woo	29.150	78	78	68	10	7.183	Morning cool and gloomy.
6	Mathias Barbosa		28.602	68	67	59	8	5.496	Slight rain, which made the track slippery.
”	Morro de Mideiras		27.650	74	72	67	5	6.945	Clear about one o'clock.
7	Alcaide Mòr		27.701	65	65½	60	5½	5.710	Dull and cold morning.
”	Chapeo d'Uvas		27.600	74	75½	68	7½	7.221	Fine evening.
8	”		27.751	64	65	61	4	5.908	Cloudy, afterwards heavy rain.
9	Montiqueira		27.351	59	58	52	6	4.129	Severely cold morning, mist and rain.
”	Height of the Serra		26.601	64½	64	59	5	5.525	About eleven A. M. foggy.
10	Barbacena	Open plain with little timber but the pine.	26.552	50	52	50	2	4.179	Morning severely cold.
11	Four leagues in advance		....	..	58	..	..	....	Felt the cold severely.—From a variety of causes prevented examining the Barometer or Hygrometer.
12	Queluz Villa		27.003	60½	59½	50	9½	4.120	Thick fog, afterwards oppressive sun.
13	Congonha do Campo		27.302	59½	59½	49	10	3.988	Clear morning.
14	Capao d'Olanda Topaze Mine	Very mountainous country with little wood	26.250	65	66	52	12	4.352	Bright morning.
15	Villa Rica		26.370	64	63	54	9	4.689	Fine.
16	”		26.400	65	65½	57	8	5.156	Fine—Observation made in the morning.
17	”		26.420	74	75	68	7	7.221	Fine, idem at noon.
18	Mariana		27.901	68	67	62	5	6.072	Fine.
”	Itacolumi of Marianna		26.254	70½	73½	67	5½	6.933	At one P. M.
”	Maynerte		27.950	79	76	68	8	7.208	In the evening.
19	”		28.208	68	69½	65	4	6.567	Thick fog.
20	Mangelegnas		27.802	75	74	70	4	7.715	Very thick fog.
21	Bandeira		27.601	68	57	63	4	6.265	Cloudy morning—Torrents of rain in the afternoon.
22	Villa Rica		26.394	69	69½	67	2	6.988	Gloomy. Noon observation.
23	”		26.380	73	73½	70	3	7.728	Fine.
24	”		26.412	72	72	69	3	7.495	Very foggy.
25	”		26.392	71	71½	68	3	7.277	Clearer.
26	”		26.361	69	69½	65	4	6.567	Cloudy.
27	”		26.376	70	70	65	5	6.556	Sun obscured.
28	”		26.381	70	70½	66	4½	6.863	Cloudy, light rain.
29	”		26.400	73	74	68	6	7.233	Morning foggy, afterwards clear.
30	”		26.390	73	73	69	4	7.482	Fine, a little foggy.
Oct. 1	”		26.416	72	71½	68	3½	7.277	Cloudy and thick mist.
2	”		26.382	70	69½	67	2½	6.988	Thick mist—Dreadful storm.
3	Coxo de Agua	Abounding in wood.	The barometer was left at Villa Rica during this excursion.		78	74	4	8.746	At two P. M. great thunderstorm.
4	Congonha de Sabará				83	80	3	10.536	At three P. M. idem.
5	Sabará				87	85	2	12.210	Very warm—Violent storm at night.
6	Caete				78	74	4	8.746	Storm of thunder and rain at four P. M.
7	St. Joao				71	65	6	6.544	Fine.
8	Inficionado				70	65	5	6.556	Foggy.
9	Vamos vamos				71	64	7	6.427	Foggy.
10	Villa Rica		26.378	67	67	64	3	6.471	Thick Scotch mist.
11	Villa Rica		26.408	66	66½	62	4	6.082	Idem.
12	”		26.400	67	67	63	4	6.265	Idem.
13	”		26.398	68	68½	65	3	6.587	Idem.
14	”		26.399	68½	68	62	6	6.061	Idem.
15	”		26.406	70	70½	65	5½	6.556	Idem.

On the 15th October I began to retrace my steps to Rio de Janeiro. Having left the barometer at Villa Rica, I made no kind of observations on the weather. The rains having commenced, the roads were in some places in almost an impassable state, and I scarcely think the barometer could have escaped, from the many falls my mule experienced.

I had imagined that the great humidity at Rio proceeded from the saline particles blown over by the sea breeze, but on examining the foregoing register, it will be remarked, that there was more vapour in the air on the 19th and 23d of August, before the sea breeze had commenced, than on the preceding days. I have no doubt, therefore, that when the land breeze prevails all day, which sometimes, though fortunately rarely, happens, the most vapour is contained in the air; and it seems to me this must be the case.

Beyond the Serra de Montigueira the track leaves the mountainous and thickly-wooded country, and crosses a high table land, where the pine is the only tree that seems to flourish. The height of this from the average of the barometrical observations above the sea, may be about 3720 English feet. Baron Humboldt gives the lower limit of the Mexican Pine (19 N. Lat.) at 1150 metres = 3769 English feet. I have seen this species growing in still lower situations in Brazil, but certainly with not so much luxuriance.

The means of the observations made at Villa Rica, are as follows:—

Bar. 26.393—Attached and Detached Ther. 69½°—Dew point 65°, and grains of vapour in cubic foot 6.577. Its consequent height above the sea 3,969 feet.

The mean quantity of vapour observed by Mr. Daniell, for the two years ending with the summer of 1821, was, grs. 3.652, not much more than half the mean at Villa Riça. The prevailing winds there were south and south-east.

I remarked invariably the barometer to stand lower, and the quantity of vapour more considerable, in the evening than the following morning. When overlooking some of the thick woods, it was curious to see the warm vapour ascending like smoke from

particular spots where the foliage did not form a meçhanical obstruction.

On the excursion made from Villa Rica to Sabará, it will be seen that violent thunderstorms were experienced almost daily: nothing causes so much attention to be paid to the weather as being exposed to its changes, and I could not help noticing the way these storms commenced. The sky was perfectly clear until about two or three o'clock, when some light white clouds were seen approximating the sun with great rapidity. Sometimes they all passed, but if one lingered, as if within its influence, thunder was heard, and in a few minutes no remains of a blue sky were visible. The storm commenced directly, and the change that took place in the temperature often caused a kind of whirlwind.

As after all, perhaps, we must search for the cause of that singular excrescence the goitre or wen, in the state of the air or vicissitudes of climate, it may not be irrelevant to mention that I met by far the greater number of persons afflicted with this complaint near Sabará.

From the degree of cold in the province of the mines, the hue of the negroes is much deeper than in Rio de Janeiro. The *Mineiros* who come down complain much of the heat, and have their health affected. This may proceed, however, from other causes, such as excess in fruits, which are unknown in their province, and a mode of life entirely different. I am inclined to think, on the whole, that foreigners would consider the coast more healthy than the interior.

Having reached Rio de Janeiro, I embarked on board His Majesty's ship Owen Glendower for England on the 22d November, and as soon as the usual sickness had abated, recommenced my observations with the hygrometer. The Hon. Captain Spencer, whose only aim seemed that of rendering all under his command and on board his ship perfectly happy, and in which it is almost superfluous to say he was most successful, dedicated a portion of his time to, and took considerable interest in, these experiments. Many of them recorded here were conducted by him, and he indeed suggested an improvement in the instrument

(that of colouring the bulb,) which on our arrival in England we found had been already contrived.

The hygrometer was accidentally broken on the 27th December, and, being provided with only one, my observations ceased on that day. When I commenced using the instrument, I was almost afraid to touch it, from its apparent delicacy, but was soon convinced, from the many rude shocks it underwent, that it was stronger than I had imagined; more than common carelessness, indeed, is required to break it. I may be permitted to add, that I think no traveller will find any inconvenience from carrying this hygrometer, or its accompaniment a small stock of ether; the latter I usually placed among my linen.

Although the observations, of necessity, ended here, I had the gratification of thinking they were continued through the south-east trade, south of the equator, and until we were on the northern limit of the north-east trade, which it is well known prevails on the northern side. On examining the register it will appear that on the days when the trades were fresher, there was a slight diminution of vapour; and that as we approached near the equator, we approximated the point of saturation, the precise position of which, probably, varies according to the longitude and season, as is the case with the trades themselves.

In these winds there is something so exhilarating that one with difficulty believes so much vapour exists as the hygrometer indicates. Baron Humboldt, who did not proceed farther south than ten degrees north latitude in crossing the Atlantic, marks eighty-six degrees of Saussure's instrument in that latitude.

A set of experiments conducted on board some of the foreign ships that endeavour to pass the line in improper longitudes, and consequently experience calms of many days' duration with much rain, would prove particularly interesting.

METEOROLOGICAL OBSERVATIONS, made on board His Majesty's Ship Owen Glendower, Captain the Hon. R. C. Spencer, during a voyage from Rio de Janeiro to Spithead, commencing 1st December.

Time of the day.	Lat. S.	Long. W.	Winds.	Remarks, State of the Weather, &c.	Bar.	Ther.	Dew Point	Difference	Grains of Vapour in Cubic Foot	Time of the day when Hygrometer was used
8 A.M. noon 8 P.M.	24°.25	25°.21	N N N E	*Saturday* 1st *December*.—Fine pleasant weather with steady breeze; towards sunset there were many clouds, chiefly nimbi, cumuli, and strati.	30.09 30.10 30.08	76 76	73 72	3 4	8.488 8.212	1 P.M. 6 P.M.
8 A.M. noon 8 P.M.	21.17	23.13	N ½ E N W by N	*Sunday* 2d *December*.—Rather fresh breeze and fine weather. Evening a few scattered cumuli, mostly in the south-east quarters.	30.05 30.06 30.08	76 76	70 70	6 6	7.688 7.688	10 A.M. 3.3 P.M.
8 A.M. noon 8 P.M.	23.25	21.38	N N by W Calm	*Monday* 3d *December*.—Light breezes, wind dying away fast. Evening calm and fine; a few dispersed clouds.	30.09 30.10 30.13	74 77	69 72	5 5	7.469 8.198	9 P.M. 4 P.M.
8 A.M. noon 8 P.M.	22.31	21.46	E N E by E N E by N E N E	*Tuesday* 4th *December*.—Light breezes and fine weather; sky perfectly clear until the evening, when the wind died away clouds gathered thick all round.	30.11 30.11 30.09	76½ 76½	71 70	5½ 6½	7.951 7.689	9 A.M. 3 P.M.
8 A.M. noon 8 P.M.	20.57	22.24	N N E E N E E by N N E	*Wednesday* 5th *December*.—Cloudy dull weather early; but afterwards beautifully clear, with a light breeze; not a cloud to be seen in the evening; breeze rather fresher.	30.09 30.09 30.07	76 7.	70 72	6 4	7.640 8.213	9 A.M. 3 P.M.
8 A.M. noon 8 P.M.	18.52	22.49	East E by S got the trade about noon	*Thursday* 6th *December*.—In the morning a squall of wind and rain for a quarter of an hour; weather finer than yesterday. In the evening fresh breeze and steady.	30.10 30.11 30.11	77 79	71 70	6 9	7.937 7.676	9 A.M. 3 A.M.
8 A.M. noon 8 P.M.	15.37	22.48	East E S E E by S E S E	*Friday* 7th *December*.—Fresh trade wind and cloudy; fine at noon and clear; evening a few clouds scattered, chiefly cumuli.	30.12 30.10 30.08	76 76	72 70	4 6	8.213 7.689	9 P.M. 3 P.M.
8 A.M. noon 8 P.M.	11.54	22.33	E S E E by S S E by E	*Saturday* 8th *December*.—Trades varying in point of strength all day; weather fine all the forenoon; in the evening fresh trade and cloudy weather.	30.07 30.07 30.01	76 77	70 71	6 6	7.689 7.937	8¼ A.M. 3 P.M.
8 A.M. noon 8 P.M.	8.6	22.6	E S E E by S S E S E by S	*Sunday* 9th *December*.—Fine weather; fresh trade wind; in the afternoon fresh breezes and cloudy; wind drawing aft; evening fine weather; many flying fish.	30.02 30.01 29.97	78 77	72 71	6 6	8.185 7.937	8¼ A.M. 3 P.M.
8 A.M. noon 8 P.M.	4.55	22.	S E by S E S E S E by N S E by S	*Monday* 10th *December*.—Trade tolerably fresh, but fell off in the evening; cloudy, small halo round the moon.	29.96 29.96 29.96	79 79½	74 73	5 6½	8.732 8.438	9 A.M. 3 P.M.
8 A.M. noon 8 P.M.	2.11	22.3	S E S S E S E by E	*Tuesday* 11th *December*.—Light winds; breeze lighter in the evening; a few straggling clouds.	29.96 29.97 29.98	80 79	75 74	5 5	9.013 8.732	8¾ A.M. 3 P.M.
8 A.M. noon 8 P.M.	0.08N	21.53	S E by E S E by S E by S S E	*Wednesday* 12th *December*.—Light trades and fine weather; in the evening wind fresher; a few scattered clouds.	30. 29.98 29.95	79½ 79½	76 76	3½ 3½	9.334 9.334	8.50 A.M. 3 P.M.
8 A.M. noon 8 P.M.	2.14	22.	S S E E by S S E	*Thursday* 13th *December*.—The wind light all day; weather clear; towards evening fresher and some clouds appeared; nimbi, cumuli, and strati.	29.92 29.92 29.92	80 82	78 79	2 3	9.958 10.263	8¾ A.M. 3¼ P.M.

METEOROLOGICAL OBSERVATIONS, &c., continued.

Time of the day.	Lat. N.	Long. W.	Winds.	Remarks, State of the Weather, &c.	Bar.	Ther.	Dew Point	Difference	Grains of Vapour in Cubic Foot	Time of the day when Hygrometer was used
8 A.M. noon 8 P.M.	4.19°	28.8°	S S E N E by N E by S variab, & calm	*Friday* 14th *December.*—Rain early in the morning; trade left us at five A. M.; the weather continued cloudy and dull all day; wind light and unsettled; much lightning after dark.	29.92 29.92 29.92	78 80	75 78	3 2	9.044 9.958	8.50 A.M. 3.30 P.M.
8 A.M. noon 8 P.M.	5.18	22.14	Calm S S W E by S N E by E	*Saturday* 15th *Dec.*—This day set in with a heavy squall of rain, which went astern; lightning; after a few intervals of calm we got the north-east trade; a few drops of rain in the evening.	29.90 29.88 29.86	81½ 80½	76½ 78	5 2½	9.405 9.949	8.50 A.M. 3.30 P.M.
8 A.M. noon 8 P.M.	6.56	23.51	E N E N E by E N E by E N N E	*Sunday* 16th *December.*—Dull and cloudy; dark black clouds; Fresh trade; in the evening fresher; weather cloudy.	29.93 29.90 29.93	82 80	78 77	4 3	9.921 9.638	8.40 A.M. 1.15 P.M.
8 A.M. noon 8 P.M.	9.13	24.58	E by N E N E N E by E E N E	*Monday* 17th *December.*—Moderate trade winds with thick cloudy weather, very hot; in the evening many nimbi and cumulo-strati.	30.01 29.97 30.	80 81	77 75	3 5	9.638 9.013	8.50 A.M. 4 P.M.
8 A.M. noon 8 P.M.	11.41	26.55	N E by E N E N E by E	*Tuesday* 18th *December.*—Still cloudy; dark bank of clouds; some strati and cumuli; fresh trades, a nimbus or two.	30.08 30.01 30.04	77 79	73 73	4 6	8.474 8.415	8.55 A.M 3.40 P.M.
8 A.M. noon 8 P.M.	14.18	29.1	N E N E by E E N E E by N	*Wednesday* 19th *December.*—Strong trades and fine weather with a few scattered clouds; in the evening a dark thick bank of clouds; some cumuli.	30.07 30.03 30.04	76 76	70 72	6 4	7.689 8.213	8.55 A.M. 3.55 P.M.
8 A.M. noon 8 P.M.	17.11	30.12	E by N E N E E	*Thursday* 20th *December.*—Weather similar to that of yesterday until the afternoon, when the wind lulled a short time, and a small quantity of rain fell; breeze freshened and afterwards cloudy.	30.11 30.10 30.11	76 77	73 74	3 3	8.482 8.762	8.45 A.M. 4 P.M.
8 A.M. noon 8 P.M.	20.8	31.3	East, E by N E by N E N E	*Friday* 21st *December.*—Strong gales and squally with thick clouds; in the afternoon weather fine; cumuli over the horizon; cumulo-strati above.	30.17 30.16 30.20	75 75	72 72	3 3	8.227 8.227	8.50 A.M. 3.55 P.M.
8 A.M. noon 8 P.M.	22.25	32.15	E by N N E by E N E N E by N	*Saturday* 22d *December.*—Moderate breezes and fine weather; two or three nimbi at different times, but no rain; cumuli.	30.21 30.21 30.24	74 74	71 68	3 6	7.978 7.234	8.50 A.M. 4 P.M.
8 A.M. noon 8 P.M.	21.30	34.18	N E E N E E by N N E	*Sunday* 23d *December.*—Light winds and very fine weather, as the day advanced wind became lighter; some clouds; one large nimbus, the rest cumuli; sun set clouded.	30.28 30.29 30.31	70½ 74	67 68	5½ 6	6.970 7.233	8.45 A.M. 3.30 P.M.
8 A.M. noon 8 P.M.	26.1	35.43	N E E N E N E by N N by W N E	*Monday* 24th.—Cloudy with showers of rain and a light variable breeze in the morning; breeze stronger in the afternoon, the weather clearer; light again and cloudy; cumuli and cumulo-strati chiefly.	30.34 30.34 30.34	72 73	70 66	2 7	7.742 6.822	8¾ A.M. Gulf weed 3½ P.M.
8 A.M. noon 8 P.M.	26.36	36.11	N N N E N E by N N E	*Tuesday* 25th *December.*—Thick cloudy weather and variable wind in the forenoon; the breeze fresher and less cloudy; in the evening high cumuli and black bank clouds.	30.34 30.34 30.35	70½ 72	66 67	4½ 5	6.858 6.946	8½ A.M. Gulf weed 3¾ P.M.
8 A.M. noon 8 P.M.	27.50	38.26	N N E E N E N E E N E E	*Wednesday* 26th *December.*—Weather dull, and wind light, but squally; evening fine, but breeze very light.	30.38 30.35 30.31	70½ 69	67 65	3½ 4	6.970 6.568	8.50 A.M. Gulf weed 3.50 P.M.

ART. V. *A Table of Prime Equivalent Numbers, for the use of the Chemical Students in the Royal Institution.*

THE following Table of Prime Equivalents refers to hydrogen as *unity*, and is founded upon the assumption that the specific gravity of hydrogen is to that of oxygen as 1 to 16; 100 cubic inches of hydrogen being regarded with Dr. Prout, (*Annals of Phil.*, VI., 322.), as weighing, at mean temperature and pressure, 2.118 grains, and 100 cubic inches of oxygen 33.8 grains; water, therefore, composed of two volumes of hydrogen, and one volume of oxygen, consists, by weight, of 1 of hydrogen and 8 of oxygen. The weight of 100 cubic inches of chlorine, at mean temperature and pressure, is assumed as =76.248 grs., so that the specific gravity of hydrogen is to that of chlorine as 1 to 36; these numbers, therefore, will represent the weights of the elements of muriatic acid gas, which consists of equal volumes of hydrogen and chlorine; and, assuming water to be a compound of 1 prime of hydrogen and 1 of oxygen, and muriatic acid, of 1 prime of hydrogen and 1 of chlorine, the prime equivalent of water will be 9, and that of muriatic acid 37. The specific gravity of hydrogen, compared with nitrogen, is as 1 to 14.—100 cubic inches of nitrogen, therefore, will weigh, at mean temperature and pressure, 29.65 grains;' and its sp. gr. compared with that of oxygen, will be as 14 to 16. Ammonia consists of 3 volumes of hydrogen and 1 of nitrogen, *condensed into the space of 2 volumes*; so that 100 cubical inches of ammonia will weigh 18 grs. and, assuming it to consist of 1 prime of nitrogen and 3 of hydrogen, its prime equivalent will be =17.

It will be observed, from the above instances, that, supposing the *data* correct, oxygen, chlorine, and nitrogen, are represented by numbers which are entire multiples of hydrogen, and experiment bears us out in assuming that all other bodies admit of similar numerical representation. The following Tables exhibit a series of equivalents, each of which is a whole number, in reference to hydrogen as *unity*, and which, with the aid of the sliding-rule, as used in Dr. Wollaston's scale, will, it is hoped,

be found of no inconsiderable use and convenience to the chemical student and operator. In the first table, these prime equivalent numbers are arranged alphabetically; and in the second, in numerical succession.

TABLE I.

ACID, acetic	50
arsenic	62
arsenious	54
benzoic	120
boracic ?	22
carbonic	22
chloric	76
chloriodic	161
chlorocarbonic	50
chromic	52
citric (dry)	58
crystallized (2 water)	76
columbic ?	152
ferrocyanic	?
fluoboric ?	22
fluoric	17
fluosilicic	24
gallic ?	63
hydriodic	126
hydrochloric	37
hydrocyanic	27
hydrofluoric	17
hyposulphurous	24
hyposulphuric	36
iodic	165
malic	70
molybdic	72
molybdous	64
muriatic	37
nitric (dry)	54
liquid (sp. gr. 1.50)	72
nitrous	46
oxalic	36
crystallized (4 water)	72
Acid, oxyodic	165
oxychloric	92
phosphoric	28
phosphorous	20
saccholactic	105
succinic	50
sulphuric (dry)	40
liquid (sp. gr. 1.85)	49
sulphurous	32
tartaric	67
crystallized, (1 water)	76
tungstic	120
uric	45 ?
Alum (dry)	260
Alum (crystallized 25 water)	485
Alumina	26
sulphate	66
Ammonia	17
acetate	67
bi-carbonate	61
borate ? (dry)	39
carbonate	39
chlorate	93
citrate	75
fluoborate	39
hydriodate	143
iodate	182
molybdate	89
muriate	54
nitrate	71
oxalate	53
phosphate	45
phosphite	37
succinate	67

Ammonia, sulphate	57
sulphite	49
tartrate	84
potassa-tartrate	198
Antimony	45
chloride	81
iodide	170
peroxide	61
protoxide	53
sulphuret	61
potassa-tartrate	288
Arseniate of ammonia	79
potassa	110
soda	74
Arsenic	38
acid	62
chloride	100
iodide	288?
white oxide	54
Arsenious acid	54
Azote	14
Barium	70
chloride	106
iodide	195
peroxide	86
phosphuret	82
sulphuret	86
Baryta	78
acetate	128
arseniate	140
arsenite	132
benzoate	198
borate	100
carbonate	100
chlorate	154
chromate	130
citrate	136
hydrate	87
iodate	243
nitrate	132
oxalate	114
Baryta, phosphate	106
phosphite	98
succinate	128
sulphate	118
sulphite	110
tartrate	145
tungstate	198
Benzoic acid	120
Bismuth	71
acetate	129
arseniate	141
benzoate	199
chloride	107
citrate	137
iodate	244
iodide	196
nitrate	133
oxalate	115
oxide	79
phosphate	107
phosphuret	83
sulphate	119
sulphuret	87
tartrate	146
Boracic acid	22 ?
Borax	?
Boron	6?
Cadmium	56
carbonate	86
chloride	92
iodide	181
nitrate	118
oxide	64
phosphate	92
phosphuret	68
sulphate	104
sulphuret	72
Calcium	20
chloride	56
fluoride	36
iodide	145

Calcium, oxide	28
peroxide	?
phosphuret	32
sulphuret	36
Calomel	236
Camphoric acid	?
Carbon	6
protochloride	42
hydrochloride	50
oxide	14
phosphuret	18
sulphuret	38
Carbonic acid	22
oxide	14
Carburet of nitrogen	26
sulphur	38
phosphorus	18
Carburetted hydrogen	7
Cerium	46 ?
Chloric acid	76
Chlorine	36
Chromium	28
oxide	36
Cobalt	30
acetate	88
arseniate	100
benzoate	158
borate	60
carbonate	60
chloride	66
citrate	96
iodide	155
nitrate	92
oxalate	74
peroxide	?
phosphate	66
phosphuret	42
protoxide	38
sulphate (dry)	78
crystallized (7 water)	141
sulphuret	46
tartrate	105
Columbium	?
Copper	64
bisulphuret	96
iodide	189
perchloride	136
pernitrate	188
persulphate	160
crystallized (10 wat.)	250
perphosphate	136
phosphuret	76
protochloride	100
protoxide	72
peroxide	80
Corrosive sublimate	272
Cyanogen	26
Fluorine	16
Glucina	26
Glucinum	18
Gold	200
chloride	236
iodide	325
oxide	1+3=224
sulphuret	1+3=248
chloride of, & sodium (dry)	296
crystallized, 8 water,	368
Hydrogen	1
Iodine	125
Iron	28
protochloride	64
perchloride	82
peroxide	40
protoxide	36
sulphate (dry)	76
crystallized (7 water)	139
protosulphuret	44
Lead	104
acetate	162
arseniate	174
benzoate	232
borate	134
carbonate	134
chlorate	188

Lead, chloride	140
chromate	164
citrate	170
deutoxide	116
iodate	277
iodide	229
malate	182
molybdate	184
nitrate	166
oxalate	148
peroxide	120
phosphate	140
phosphite	132
phosphuret	116
protoxide	112
succinate	162
sulphate	152
sulphite	144
sulphuret	120
tartrate	179
Lime	28
acetate	78
arseniate	90
benzoate	148
biphosphate	84
borate	50 ?
carbonate	50
chlorate	104
citrate	86
chromate	80
hydrate	37
iodate	193
oxalate	64
phosphate	56
phosphite	48
succinate	78
sulphate	68
crystallized	86
sulphite	60
tartrate	95
tungstate	148
Lithia	18
Lithia, carbonate	40
nitrate	72
phosphate	46
sulphate	58
Lithium	10
chloride	46
iodide	135
sulphuret	26
Magnesia	20
ammonio-phosphate	93
bicarbonate	64
borate ?	42
carbonate	42
hydrate	29
nitrate	74
phosphate	48
sulphate (dry)	60
crystallized, (7 wat.)	123
tartrate	87
Magnesium	12
chloride	48
iodide	137
phosphuret	24
sulphuret	28
Manganese	28
acetate	86
benzoate	156
carbonate	58
chlorate	112
chloride	64
citrate	94
deutoxide	40
oxalate	72
peroxide	44
phosphate	64
phosphuret	40
protoxide	36
succinate	86
sulphate	76
tartrate	103
Mercury	200
bisulphuret	232

ercury, bicyanuret	252
erchloride	272
periodide	450
pernitrate	324
peroxide	216
perphosphate	272
persulphate	296
protochloride	236
protonitrate	262
protosulphate	248
protoxide	208
Molybdenum	48
protoxide	56
Morphia	322
carbonate	344
nitrate	376
sulphate	362
Nickel	30
acetate	88
arseniate	100
benzoate	158
borate	60
carbonate	60
chloride	66
citrate	96
iodide	155
nitrate	92
oxalate	74
peroxide	?
phosphate	66
phosphuret	42
protoxide	38
sulphate (dry)	78
crystallized (7 wat.)	141
sulphuret	46
tartrate	105
Nitric oxide	30
Nitrogen	14
Nitrous oxide	22
Olefiant gas	7
Osmium	?
oxide	?

Oxygen	8
Palladium	?
oxide	?
Phosphorus	12
Platinum	96
ammonio-muriate	196
perchloride	142
peroxide	112
bi-phosphuret	120
bi-sulphuret	128
Potassa (dry)	48
acetate	98
arseniate	110
arsenite	102
benzoate	168
bicarbonate	92
binarseniate	172
binoxalate	120
biphosphate	104
bisulphate	128
bitartrate	182
borate	70 ?
carbonate	70
chlorate	124
chromate	100
citrate	106
hydrate	57
iodate	213
molybdate	120
nitrate	102
oxalate	84
phosphate	76
quadroxalate	192
succinate	98
sulphate	88
sulphite	80
tartrate	115
tungstate	168
Potassium	40
chloride	76
iodide	165
peroxide	64

Potassium, phosphuret	52
protoxide (dry)	48
sulphuret	56
Rhodium	?
protoxide	?
Selenium?	41
Silica	16
Silicium	8
Silver	110
acetate	168
arseniate	180
arsenite	172
benzoate	238
borate?	140
carbonate	140
chlorate	194
chloride	146
chromate	170
citrate	176
iodate	283
iodide	235
molybdate	190
nitrate	172
oxalate	154
oxide	118
phosphate	146
sulphate	158
sulphite	150
sulphuret	126
tartrate	185
tungstate	238
Soda acetate	82
arseniate	94
arsenite	86
benzoate	152
bicarbonate	76
borate?	54
carbonate (dry)	54
crystallized, (7 wat.)	117
chlorate	108
chromate	84
citrate	90
Soda, hydrate	41
iodate	197
molybdate	104
nitrate	86
oxalate	68
succinate	82
sulphate (dry)	72
crystallized (10 wat.)	162
sulphite	64
tartrate	99
and potassa	214
Sodium	24
chloride	60
iodide	149
phosphuret	36
peroxide	36
protoxide	32
sulphuret	40
Starch?	142
Strontia	55
acetate	105
borate?	77
carbonate	77
citrate	113
hydrate	64
oxalate	91
phosphate	83
sulphate	95
tartrate	122
Strontium	47
chloride	83
iodide	172
phosphuret	59
sulphuret	63
Strychnia	380
nitrate	434
sulphate	420
Sugar	?
Sulphur	16
carburet	38
iodide	141
phosphuret	28

Sulphuretted hydrogen	17
Tannin?	71
Tellurium	38
chloride	74
oxide	46
Tin	59
bisulphuret	91
iodide	184
peroxide	75
protoxide	67
perchloride	131
protochloride	95
sulphuret	75
phosphuret	71
Tungsten	96
Tungstic acid	120
Titanium	?
Uranium	?
oxide	?
Uric acid	45?
Water	9
Yttria	40
Yttrium?	32
Zinc	35
Zinc, acetate	93
arseniate	105
benzoate	163
borate	65
carbonate	65
chlorate	119
chloride	71
citrate	101
iodate	208
iodide	160
nitrate	97
oxalate	79
oxide	43
phosphate	71
phosphuret	47
succinate	93
sulphate (dry)	83
crystallized, (7 wat.)	146
sulphite	75
tartrate	110
Zirconia	45?
Zirconium	37?

TABLE II.

Hydrogen	1
Carbon Boron?	6
Carburetted hydrogen	7
Oxygen Silicium	8
Water	9
Lithium	10
Magnesium Phosphorus	12
Phosphuretted hydrogen	13
Nitrogen Carbonic oxide Bihydroguret of phosphorus	14
Sulphur 2 Oxygen Silica Fluorine	16
Ammonia Sulphuretted hydrogen Hydrofluoric acid	17
Alumium Lithia Phosphuret of carbon Glucinum 2 Water	18
Phosphorous acid Magnesia Calcium	20

Carbonic acid	22
Nitrous oxide	
Boracic acid ?	
Fluoboric acid ?	
Sodium	24
Phosphuret of magnesium	
3 Oxygen	
Hyposulphurous acid	
Fluosilicic acid	
Glucina	26
Alumina	
Cyanogen	
Sulphuret of lithium	
Hydrocyanic acid	27
3 Water	
Sulphuret of magnesium	
Lime	28
Phosphoric acid	
Phosphuret of sulphur	
Iron	
Manganese	
Chromium	
Hydrate of magnesia	29
Nitric oxide	30
Nickel	
Cobalt	
Sulphurous acid	32
Soda	
Phosphuret of calcium	
Yttrium ?	
4 Oxygen	
Zinc	35
Chlorine	36
Hyposulphuric acid	
Protoxide of iron	
——— manganese	
——— chromium	
Peroxide of sodium	
Phosphuret of sodium	
Sulphuret of calcium	
Fluoride of calcium	
Oxalic acid (dry)	
Water	
Muriatic acid	37
Phosphite of ammonia	
Hydrate of lime	
Zirconium ?	
Sulphuret of carbon	38
Arsenic	
Tellurium	
Protoxide of nickel	
——— cobalt	
orate of ammonia ? (dry)	39
luoborate of ammonia ?	
Sulphuric acid	40
Potassium	
Yttria ?	
Sulphuret of sodium	
Carbonate of lithia	
Deutoxide of manganese	
Peroxide of iron	
Phosphuret of manganese	
Phosphuret of iron	
5 Oxygen	
Hydrate of soda	41
Selenium ?	
Protochloride of carbon	42
Carbonate of magnesia	
Borate of magnesia ?	
Phosphuret of nickel	
——— cobalt	
Oxide of zinc	43
Protoxide of chlorine	44
Peroxide of manganese	
Protosulphuret of iron	
Phosphate of ammonia	45
Antimony	
Zirconia ?	
Uric acid ?	
5 Water	

Substance	Number	Substance	Number
Nitrous acid	46	Strontia	55
Chloride of lithium	46	Sulphuret of potassium	56
Phosphate of lithia	46	Chloride of calcium	56
Oxide of tellurium	46	Phosphate of lime	56
Sulphuret of nickel	46	Protoxide of molybdenum	56
Sulphuret of cobalt	46	Cadmium	56
Cerium?	46	7 Oxygen	56
Strontium	47	Sulphate of ammonia	57
Phosphuret of zinc	47	Hydrate of potassa	57
Protochloride of phosphorus	48	Muriate of magnesia	57
Potassa (dry)	48	Sulphate of lithia	58
Phosphate of magnesia	48	Carbonate of manganese	58
Molybdenum?	48	Sulphate of alumina	58
Chloride of magnesium	48	Citric acid (dry)	58
Phosphite of lime?	48	Phosphuret of strontium	59
6 Oxygen	48	Tin	59
Sulphite of ammonia	49	Chloride of sodium	60
Liquid sulphuric acid (1 wr.)	49	Persulphuret of iron	60
Hydrochloride of carbon	50	Phosphate of soda	60
Carbonate of lime	50	Sulphite of lime	60
Borate of lime	50	Sulphate of magnesia (dry)	60
Acetic acid	50	Carbonate of nickel	60
Succinic acid?	50	——— cobalt	60
Chlorocarbonic acid	50	Borate of nickel?	60
Sulphuret of zinc	51	——— cobalt?	60
Chloride of sulphur	52	Sulphuret of antimony	61
Phosphuret of potassium	52	Peroxide of antimony	61
Chromic acid	52	Bi-carbonate of ammonia	61
Protoxide of antimony	53	Arsenic acid	62
Oxalate of ammonia	53	Gallic acid	63
Dry nitric acid	54	Sulphuret of strontium	63
Muriate of ammonia	54	7 Water	63
Carbonate of soda	54		
Protoxide of cerium	54		
Arsenious acid	54		
6 Water	54		

Substance	Number
Peroxide of potassium	64
Sulphite of soda	
Chloride of manganese	
Protochloride of iron	
Oxide of cadmium	
Bi-carbonate of magnesia	
Copper	
Molybdous acid	
Sulphuret of molybdenum	
Phosphate of manganese	
8 Oxygen	
Oxalate of lime	
Hydrate of strontia	
Carbonate of zinc	65
Borate of zinc ?	
Chloride of nickel	66
——— cobalt	
Sulphate of alumina	
Phosphate of nickel	
——— cobalt	
Protoxide of tin	67
Tartaric acid (dry)	
Acetate of ammonia	
Succinate of ammonia	
Peroxide of chlorine	68
Sulphate of lime	
Phosphuret of cadmium ?	
Oxalate of soda	
Carbonate of potassa	70
Borate of potassa ?	
Barium	
Acetate of magnesia	
Malic acid	
Nitrate of ammonia	71
Phosphuret of tin	
Bismuth	
Tannin ?	
Chloride of zinc	
Phosphate of zinc	
Liquid nitric acid (2 water)	72
Cryst.[d] oxalic acid (4 water)	
8 Water	
Sulphate of soda (dry)	
Nitrate of lithia	
Protoxide of copper	
Oxalate of manganese	
Molybdic acid	
Sulphuret of cadmium	
9 Oxygen	
Nitrate of magnesia	74
Arseniate of soda	
Oxalate of nickel	
——— cobalt	
Chloride of tellurium	
Sulphuret of tin	75
Citrate of ammonia	
Peroxide of tin	
Sulphite of zinc	
Chloric acid	76
Crystalliz.[d] citric acid (2 wr.)	
Cryst.[d] tartaric acid (1 wr.)	
Chloride of potassium	
Phosphate of potassa	
Phosphuret of copper	
Bi-carbonate of soda (dry)	
Protosulphate of manganese	
——— iron (dry)	
Carbonate of strontia	77
Borate of strontia ?	
Baryta	78
Acetate of lime	
Succinate of lime	
Sulphate of nickel (dry)	
Sulphate of cobalt (dry)	
Hydrated bi-carbonate of ammonia	79
Arseniate of ammonia	
Oxide of bismuth	
Oxalate of zinc	

Sulphite of potassa	80
10 Oxygen	80
Peroxide of copper	80
Protosulphuret of copper	80
Chromate of lime	80
Chloride of antimony	81
Sugar?	81
Nitrate of lime	82
Phosphuret of barium	82
Perchloride of iron	82
Acetate of soda	82
Succinate of soda	82
Sulphate of zinc (dry)	83
Phosphuret of bismuth	83
Phosphate of strontia	83
Chloride of strontium	83
Bi-chloride of phosphorus	84
Bi-phosphate of lime	84
Chromate of soda	84
Oxalate of potassa	84
Tartrate of ammonia	84
Arsenite of soda	86
Crystallized selenite (2wr.)	86
Carbonate of cadmium	86
Acetate of manganese	86
Succinate of manganese	86
Peroxide of barium	86
Sulphuret of barium	86
Nitrate of soda	86
Citrate of lime	86
Acetate of iron	86
Hydrated baryta	87
Sulphuret of bismuth	87
Tartrate of magnesia	87
Sulphate of potassa	88
Acetate of cobalt	88
Acetate of nickel	88
11 Oxygen	88
Molybdate of ammonia	89
Arseniate of lime	90
10 Water	90
Nitrate of manganese	90
Protonitrate of iron	90
Citrate of soda	90
Oxalate of strontia	91
Bi-sulphuret of tin	91
Oxychloric acid	92
Bi-carbonate of potas.(dry)	92
Chloride of cadmium	92
Phosphate of cadmium	92
Nitrate of nickel	92
——— cobalt	92
Chlorate of ammonia	93
Ammonio-phosphate of magnesia	93
Acetate of zinc	93
Succinate of zinc	93
Citrate of manganese	94
Arseniate of soda	94
Protochloride of tin	95
Tartrate of lime	95
Sulphate of strontia	95
Bisulphuret of copper	
Citrate of nickel	
——— cobalt	
Platinum	
Tungsten?	
12 Oxygen	
Nitrate of zinc	97
Succinate of potassa	98
Acetate of potassa	98
Phosphite of baryta	98
Tartrate of soda	99
11 Water	99
Carbonate of baryta	100
Borate of baryta?	100
Persulphate of iron	100
Protochloride of copper	100
Perchloride of arsenic	100
Arseniate of nickel	100
——— cobalt	100
Chromate of potassa	100

Substance	Number
Citrate of zinc	101
Nitrate of potassa	102
Arsenite of potassa	102
Subpercarbonate of copper	102
Prototartrate of manganese	103
——— iron	103
Bi-phosphate of potassa	104
Chlorate of lime	104
Molybdate of soda	104
Sulphate of cadmium	104
Lead	104
Ammonio-phosphate of soda	105
Acetate of strontia	105
Saclactic acid ?	105
Tartrate of nickel	105
——— cobalt	105
Arseniate of zinc	105
Chloride of barium	106
Phosphate of baryta	106
Citrate of potassa	106
Phosphate of bismuth	107
Chloride of bismuth	107
Chlorate of soda	108
12 Water	108
Cryst^d nitrate of lime (3 wr.)	109
Nitrate of strontia	109
Silver	110
Arseniate of potassa	110
Tartrate of zinc	110
Sulphite of baryta	110
Protoxide of lead	112
Chlorate of manganese	112
Citrate of strontia	113
Oxalate of baryta	114
Tartrate of potassa	115
Oxalate of bismuth	115
Phosphuret of lead	116
Deutoxide of lead	116
Crystallized carbonate of soda (7 water)	117
13 Water	117
Hydrated carbonate of ammonia	118
Sulphate of baryta	118
Nitrate of cadmium	118
Oxide of silver	118
Sulphate of bismuth	119
Chlorate of zinc	119
Peroxide of lead	120
Sulphuret of lead	120
Tungstic acid	120
Molybdate of potassa	120
Binoxalate of potassa	120
Benzoic acid	120
Rhodium ?	120
Tartrate of strontia	122
Crystalliz^d sulphate of magnesia (7 water)	123
Chlorate of potassa	124
Iodine	125
Hydriodic acid	126
Sulphuret of silver	126
14 Water	126
Bi-sulphate of potassa	128
Protoxide of rhodium ?	128
Succinate of baryta	128
Acetate of baryta	128
Acetate of bismuth	129
Chromate of baryta	130
Perchloride of tin	131
Nitrate of baryta	132
Arsenite of baryta	132
Phosphite of lead	132
Nitrate of bismuth	133
Carbonate of lead	134
Borate of lead ?	134
Prototartrate of tin	134

Iodide of lithium 15 Water	135
Perchloride of copper Citrate of baryta Perphosphate of copper	136
Citrate of bismuth Iodide of phosphorus ——— magnesium	137
Cryst. sulph. of iron, (7 wr.)	139
Oxychlorate of potassa Chloride of lead Phosphate of lead Arseniate of baryta Carbonate of silver Borate of silver?	140
Iodide of sulphur Arseniate of bismuth Sulphate of nickel (crystallized, 7 water) Sulphate of cobalt (crystallized, 7 water)	141
Starch?	142
Hydriodate of ammonia	143
Sulphite of lead Peroxide of rhodium? 16 Water	144
Tartrate of baryta Iodide of calcium	145
Chloride of silver Tartrate of bismuth Phosphate of silver Crys^{d} sulphate of zinc (7 wr.)	146
Benzoate of lime Tungstate of lime Oxalate of lead	148
Iodide of sodium	149
Crystallized nitrate of baryta, (2 water) Sulphite of silver	150
Sulphate of lead Benzoate of soda Columbic acid	152
17 Water	153
Chlorate of baryta Oxalate of silver	154
Iodide of nickel ——— cobalt	155
Benzoate of manganese	156
Sulphate of silver Benzoate of nickel ——— cobalt	158
Peroxide of titanium Persulphate of copper (dry) Iodide of zinc	160
Chloriodic acid	161
Crystallized sulphate of soda (10 water) Succinate of lead Acetate of lead 18 Water	162
Benzoate of zinc	163
Chromate of lead	164
Iodic acid Iodide of potassium	165
Nitrate of lead	166
Acetate of silver Tungstate of potassa Benzoate of potassa	168
Chromate of silver Iodide of antimony Citrate of lead	170
19 Water	171
Iodide of strontium Nitrate of silver Binarseniate of potassa Arsenite of silver	172
Arseniate of lead	174
Citrate of silver	176
Tartrate of lead	179

Arseniate of silver . . . 20 Water	180
Iodide of cadmium . . .	181
Bi-tartrate of potassa . . Iodate of ammonia . . . Malate of lead	182
Iodide of tin . . . . . . Tartrate of lithia and soda Molybdate of lead . . .	184
Tartrate of silver . . .	185
Pernitrate of copper (dry) Chlorate of lead . . . . Protoxide of platinum ? .	188
Iodide of copper	189
Molybdate of silver . . .	190
Quadroxalate of potassa .	192
Iodate of lime	193
Chlorate of silver . . .	194
Iodide of barium . . .	195
——— bismuth . . .	196
Iodate of soda	197
Potassa-tart. of ammonia . Tungstate of baryta . . . Benzoate of baryta . . .	198
Benzoate of bismuth . .	199
Mercury . . . . . . Gold . . . . Tart. of lithia and potassa	200
Ammonio-tart. of potassa .	201
Iodate of zinc . . . . . Protoxide of mercury . . ——— gold . . .	208
Phosphuret of mercury . .	212
Iodate of potassa . . .	213
Tartrate of soda and potassa	214
Peroxide of mercury . . Protosulphuret of mercury	216
Prototar. of iron and potassa	218
Peroxide of gold ? . . .	224
Iodide of lead	229
Benzoate of lead . . . . Bi-sulphuret of mercury .	232
Iodide of silver	235
Protochloride of mercury . ——— gold . . .	236
Tungstate of silver . . . Benzoate of silver	238
Iodate of baryta	243
Iodate of bismuth . . .	244
Sulphuret of gold ? . . . Protosulphate of mercury .	248
Crystallized persulphate of copper (10 water) . .	250
Bi-cyanuret of mercury .	252
Alum (dry)	260
Periodide of phosphorus . Protonitrate of mercury .	262
Perchloride of mercury . Perphosphate of mercury .	272
Iodate of lead	277
Iodate of silver	283
Tartrate of antimony and potassa ?	288
Persulphate of mercury . Chloride of gold and sodium	296
Morphia ?	322
Pernitrate of mercury . .	324
Protiodide of mercury . . ——— gold . .	325
Carbonate of morphia . .	344
Sulphate of morphia . .	362
Crystallized chloride of gold and sodium (8 water) .	368
Nitrate of morphia . . .	376
Strychnia ?	380
Sulphate of strychnia . .	420
Nitrate of strychnia . . .	434
Periodide of mercury . .	450
Alum (cryst. 25 water)	485

Art. VI.—Lamarck's *Genera of Shells.*

The increasing interest that conchology excites amongst naturalists in general, and its importance to the geologist as a criterion whereby to identify corresponding strata, have determined us to devote some pages of our journal to this subject.

Amongst the organic remains of this class, there are some that are unknown, except in their fossil state, and it is only by comparing them with their recent analogues, that their place in the general series can with confidence be ascertained. To this end a competent knowledge of recent shells and their classification, is indispensable, and to obtain it some general system must be adopted as our guide. The chief difficulty at the outset is to choose the least exceptionable, "for a supposition seems to have been universally indulged, that conchology lay open as a common field for speculation, in which every individual, whether qualified or not, was at liberty to range, and exercise without restraint, his genius for invention. The consequence has been, that scarcely two writers on the subject have agreed in their opinions*." We concur in the truth of this observation, but dissent from its author and many other respectable authorities, as to the conclusion, that therefore the method of Linnæus is the one which the conchologist ought to prefer, and we hope we may do so without the imputation of belonging to the number of those, whom "ignorance or envy" have induced to raise objections "against his system or his fame." As to the latter, we can have no wish or motive to deteriorate it; but as to his arrangement of shells, "the professed foundation" of which "is upon external characters, upon those of the testaceous covering, and not upon the genus or species of the worm†," we must decline adopting it. In the first place, it has become insufficient, from the numerous additions that have been made of late years, to the catalogue of shells, and from more accurate examination of those known in

* Burrow's *Elements of Conchology.* 1815. Preface, p. vi.

† *Ibid.*, p. 50.

his day, having shewn, that in a variety of instances, many shells which he had confounded together as species of one common genus, require to be separated into several distinct genera. Secondly, the establishing a system of conchology, on the characters of the shells, is in some measure to insulate the science, and to deprive it of half its charms, by disconnecting it, as it were, from the other branches of natural history, in all of which, it is the animal, and not his dwelling, that is the leading object. Why, in this solitary instance, is the living agent to be secondary to his own work? What should we say of the naturalist, who would class the beast by his den, or the bird by her nest? The external characters have a high value; they are always essential in forming species and often genera, but still they are subordinate, when the science is regarded as one link of the great chain of life, connecting the scarcely perceptible traces of animation in the *infusoria*, with the full developement of its powers in the intelligence of *man*.

Linnæus indeed makes conchology a part of his *Systema Naturæ*, constituting the third order of the class *Vermes*; but still, in his method of studying it, comparatively so little attention is paid to the animal, as to render the science rather a *lateral branch*, than part of the main *trunk* of the system; and we suspect that some modern cultivators of it, or rather collectors of shells, almost forget that any animals are at all concerned in the business.

" Some have endeavoured," says the author quoted above, " to found a system of conchology upon the inhabitant rather than upon the shell. This plan has indeed generally been acknowledged as theoretically just, but as uniformly discovered to be defective in the execution, on account of the utter impossibility of procuring from the unfathomable recesses in which many, if not the majority, abide, a sufficient number of live and perfect specimens.

" Of those which are more readily attainable, there are parts and habitudes very difficult to be accounted for, which yet may constitute an essential difference in the animal. Were we indeed able to obtain the inmates of every known shell, and sub-

mit them to an accurate examination, still the pleasure of arrangement and consequently the diffusion of the science, must be very partial, as it would necessarily be confined to skilful anatomists and profound philosophers.

"Our knowledge of the animals being so extremely limited at present, and being likely to remain so, it becomes necessary to resign all hopes of a zoological arrangement similar to that of the other classes of the kingdom of nature*."

Had the *Histoire Naturelle des Animaux sans Vertèbres*, by the Chevalier De Lamarck, been advanced to its present state, when the preceding passage was written, we think its author would not have despaired "of a zoological arrangement" (in the department of conchology) "similar to that of the other classes of the kingdom of nature;" and as to the remark, that by its adoption the diffusion of the science would be lessened, because the *pleasure of arrangement* would be so, we think the exact contrary would ensue. The gratification of the scientific naturalist *must* be enhanced by it, whatever effect it may have on the mere collector of costly and splendid specimens.

Lamarck's work is a substantial proof that no such despair need have been entertained. We will say more—it is an effective, though perhaps not perfect, execution of that theoretical plan, whose justice Mr. Burrow acknowledges. We have accordingly given it the preference†.

It is much to be regretted, that the *Hist. Nat. des An. sans Vert.* should still be incomplete. The deplorable event which, temporarily we hope, has deprived its author of his sight, has occasioned a sad gap in the latter part of the subject, and left more than two-thirds of the genera of the univalve shells undescribed. Time, we trust, will restore to him the blessings of light, and that we shall ere long again reap the benefit of his acute and accurate observations. In the interim, we shall endeavour to supply the deficiency from the best sources within our reach.

* Burrow's *Elements of Conchology*. 1815. P. 3.

† The collection of shells in the British Museum is now arranged according to Lamarck's system.

In the descriptions we have preferred the mere anglicising many of the terms of obvious etymology, to the periphrases which their full translation would have required. In doing so, we hope we have equally avoided prolixity and obscurity, as the terms are for the most part of very common occurrence in natural history descriptions.

Lamarck, in his classification of animals, adopts what may be called an ascending scale, beginning with the lowest or most imperfect, and gradually proceeding to the most perfect. He separates them into two great divisions; the first contains those which have no vertebræ, the second those which have vertebræ. The first division is subdivided into two parts.

PART 1st.

APATHIC ANIMALS (contains 5 classes) which have no sensation, and only move in consequence of excited irritability.

1. Infusoria.
2. Polypi.
3. Radiaria.
4. Tunicata.
5. Vermes.

PART 2d.

SENSIBLE ANIMALS (contains 7 classes) which are endowed with sensations and the simple perception of objects.

6. Insecta.
7. Arachnida.
8. Crustacea.
9. Annulata.
10. Cirripeda.
11. Conchifera.
12. Mollusca.

The second division consists of only one part.

INTELLIGENT ANIMALS (contains 4 classes) endowed with sensations, and perceptions in different degrees, and the more perfect with intelligence.

13. Pisces.
14. Reptilia.
15. Aves.
16. Mammifera.

We have only to do with the four last classes or the second part of the first division.

CLASS IX.

ANNULATA*.

Animal soft, elongated, vermicular, naked or inhabiting tubes: the body furnished either with segments or transverse wrinkles; often destitute of head, eyes and antennæ; no articulated feet, but in their stead, in most, retractile bristly mammillæ disposed in lateral rows. Mouth subterminal, either simple, orbicular, or labiate, or proboscis-shaped, and often furnished with jaws.

Medulla longitudinal, knotty; nerves of sense and motion; red blood circulating in veins and arteries; respiration performed by internal or external branchiæ; branchiæ sometimes unknown.

This class comprehends three orders:

1. Annulata, without feet.
2. Annulata, with Antennæ.
3. Sedentary Annulata.

The two first orders have no testaceous covering, and consequently do not fall under our present notice. We begin therefore with the

Third Order.

SEDENTARY ANNULATA.

Animal always inhabits a tube, which it never entirely quits, and has no eyes. Branchiæ always at, or near to, one of the extremities of the body, unless the tube have a lateral opening, through its whole length. The tubes either membranous or horny, more or less incrusted externally with grains of sand and fragments of shell; or solid, calcareous and homogeneous. They are generally attached to marine substances.

The Sedentary Annulata are divided into four families, Dorsalia, Maldania, Amphitritea, and Serpulea.

DORSALIA†. (2 Genera).

1. Arenicola—has no shell.
2. Siliquaria‡.

Body tubular, unknown.

* From *annulus*, a ring, or segment.

† From *dorsum*, the back, because the branchiæ are ranged along it.

‡ From *siliqua*, a bean-pod.

Shell tubular, irregularly contorted, posteriorly attenuated, base sometimes spiral; open at the anterior extremity; a subarticulated fissure through its whole length.

Type. *Siliquaria Anguina**. (*Serpula Anguina. Linn.*)

Shell tapering, transversely striated, longitudinally furrowed; base spiral, whorls nearly contiguous. *Indian Seas.* Pl. iii. fig. 1. 7 Species. Recent and fossil.

Maldania. (2 Genera).

1. Clymene.

Body tubular, slender, cylindrical, on each side a row of bristly mammillæ.

Anterior extremity blunt, oblique, with a semicircular border projecting beyond the mouth; mouth transverse, plaited, bilabiate; lower lip very turgid. No tentacula.

Posterior extremity dilate, funnel-shaped; border divided by equal and acute indentations; internally elevated radii (branchiæ?) extending to the anus, which occupies the bottom of the funnel, and is surrounded by fleshy papillæ.

Tube slender and open at both ends, coated externally with small sand and fragments of shells. Only one species.

Clymene Amphistoma†. *Red Sea.*

2. Dentalium‡.

Body tubular, very imperfectly known; anterior extremity terminating in a conical button, surrounded by an annular membrane. Mouth terminal.

Posterior extremity dilate, spreading orbicularly; border divided into five equal lobes.

Tube testaceous, nearly regular, slightly curved, gradually diminishing towards the posterior extremity; open at both ends.

Type. *Dentalium elephantinum*§. (*Idem. Linn.*)

Tube, decagonal, subarcuate, striated. *Indian Seas* and *Europe.* Pl. iii. Fig. 2. 21 Species. Recent and fossil.

* From *anguis*, a snake.

† From *αμφι* and *στομα*, signifying open at both ends.

‡ From *dens*, a tooth. § *Elephant's.*

AMPHITRITEA. (4 Genera.)

Branchiæ, not separate nor covered by an operculum, disposed at or near the anterior part of the body.

Tube membranous or horny, more or less arenaceous.

1. Pectinaria*.

Body tubular, subcylindrical, posteriorly attenuated, a row of bristly mammillæ on each side; bristles short, fasciculated.

Anterior extremity broad, blunt, oblique, with two transverse rows of very brilliant gilt paleæ. Mouth elongated, bilabiate, surrounded with numerous short tentacula. Four branchiæ, disposed like the teeth of a comb, on the second and third segment of the body.

Tube conical, inverted, membranous, or papyraceous, arenaceous, not fixed.

Type. *Pectinaria Belgica*†.

Tube inverted, conical, membranous, mixed with small sand, about three inches long. *European Seas.* Pl. iii. Fig. 3. 2 Species.

2. Sabellaria‡.

Body tubular, subcylindrical, posteriorly attenuated; a single row of awl-shaped fascicular setæ on each side, besides spatulate setæ, and transverse laminæ fringed with hooked setæ.

Anterior extremity obliquely truncated, elliptical, crowned with six rows of very brilliant paleæ, three on each side; the external very open, the internal erect almost approaching; mouth elongate, fissure-shaped, bilabiate, situated below the anterior paleæ. Branchiæ very small, composed of numerous rows of small flat threads, near the mouth. No tentacula.

Tubes numerous, composed of agglutinated sand and fragments of shells, aggregated into a common mass, cellular on the upper side; orifices cup-shaped.

Type. *Sabellaria alveolata* §, (*Sabella alveolata. Linn.*)

Narrow tubes, at small distances, variously immersed in a depressed mass: openings cup-shaped. *European Ocean.* Pl. iii. Fig. 4. 2 Species.

* *Pecten*, a comb. † *Belgic.* ‡ From *sabulum*, coarse sand? § *Channelled.*

3. Terebella*.

Body tubular, elongated, depressed, cylindrical, posteriorly attenuated; very slight transverse annular segments; a single row of nodular and bristly mammillæ on each side.

Numerous advanced, filiform, twisted tentacula terminate its anterior part, and surround the mouth; two rows of tufted ramose branchiæ, disposed on one side below the tentacula.

Tube elongated, cylindrical, attenuated and pointed at the base, membranous, with grains of sand and fragments of shells agglutinated round it; open only at the apex.

Type. *Terebella conchilega*†.

Tubes formed of the fragments of testaceous substances; three branchiæ on each side. *Coast of Holland.* Pl. iii. Fig. 5. 3 Species.

4. Amphitrite.

Body tubular, elongated, cylindrical, posteriorly attenuated, segments numerous; a row of bristly mammillæ on each side; bundles of crooked awl-shaped setæ, on the border of a lamina.

Two remarkable terminal branchiæ, divided into very slender digitations, disposed in the form of a fan, sometimes in that of a funnel, or expanded into a disc. Two short awl-shaped filaments inserted in the inner base of the branchiæ. Mouth subterminal, between the branchiæ.

Tube elongate, cylindrical, posteriorly attenuated, membranous or coriaceous; in most, externally naked.

Type. *Amphitrite ventilabrum* ‡. (*Sabella penicillus. Linn.*)

Stems of the branchiæ very thin; branchiæ plumose, fan-shaped; body rather flattened. Pl. iii. Fig. 6. 6 Species.

Serpula§. (5 Genera.)

Branchiæ separate, or covered with an operculum. Tube solid and calcareous.

1. Spirorbis ||.

Body tubular, subcylindrical, posteriorly attenuated; six pinnate, rectractile branchiæ, disposed in rays, at the anterior

* *A little auger.* † *Shell-gatherer.*

‡ A fan for winnowing. § From *serpo*, to creep

|| From *spira*, and *orbis*, signifying a spiral orb.

extremity. Operculum pedunculated, flat at top, situated between the branchiæ.

Tube testaceous, twisted into an orbicular discoidal spire; lower surface flat, fixed.

Type. *Spirorbis nautiloides** (*Serpula spirorbis. Linn.*)

Shell discoidal, subumbilicate; the whorls rounded above, smooth, somewhat wrinkled. *The Sea, on Fusi.* Pl. iii. Fig. 7. 6 Species.

2. Serpula.

Body tubular, elongated, rather depressed, posteriorly attenuated; with numerous narrow segments. A single row of small bundles of awl-shaped and crooked setæ on each side.

Two terminal fan-shaped branchiæ, each deeply and finely digitated; digitations plumose; mouth terminal, between the branchiæ, surmounted by a pedunculated operculum, funnel or club-shaped. Tubes solid, calcareous, irregularly twisted, grouped or solitary, fixed; aperture terminal, round, very simple.

Type. *Serpula vermicularis.* (*Idem. Linn.*)

Shell creeping, tapering, curved, not spiral, sometimes slightly keeled. Pl. iii. Fig. 8. *European Ocean.* 26 Species.

3. Vermilia †.

Body tubular, elongated, posteriorly attenuated; with an external, testaceous, orbicular, simple operculum.

Tube testaceous, cylindrical, gradually attenuated posteriorly, more or less contorted, fixed laterally to marine bodies. Aperture round, border with from one to three teeth.

Type. *Vermilia rostrata* ‡.

Shell tapering, smooth, incrusted with madrepores; aperture with one sharp beak-shaped tooth. *New Holland.* 8 Species.

4. Galeolaria §.

Body tubular, with a compound testaceous operculum on the fore part.

Tubes testaceous, very numerous, cylindrical, sub-angular, straight-wavy, crowded, matted together, fixed by the base, open at the summit. Aperture orbicular, margin terminating

* *Nautilus-like.*

† From *vermis*, a worm.

‡ *Rostrum*, a beak.

§ *Galea*, a helmet.

in a spatulate lingula. Operculum orbicular, galeiform, armed on the upper part with from five to nine testaceous valves attached to its margin on one side only, the middle one linear, truncate, and larger than the others.

Type. *Galeolaria cæspitosa* *.

Shells angular; rather short, crowded together; lingula of the aperture, channelled. *New Holland.* 2 Species.

5. Magilus.

Animal unknown.

Base of the shell twisted into a short, oval spiral, with four convex contiguous whorls, the last larger than the rest, and extended into an elongated, straight-wavy tube. Tube convex above, keeled below, rather depressed, and plaited at the sides; the plaits lamellar, crowded, wavy, vertical, and thicker on one side of the tube than on the other.

One species. *Magilus antiquus* †. (*Isle of France?*)

CLASS X.

CIRRIPEDA ‡.

Animals soft, without head or eyes, testaceous, fixed. Body as if reversed, not articulated, having a mantle, with cirrous, many-jointed tentacular arms, on the upper part. Mouth rather inferior, not projecting; jaws transverse, toothed, disposed in pairs. Number of arms various, unequal, arranged in two rows, each composed of two setaceous, many-jointed, fringed cirri, covered with a horny integument, and supported on a common pedicle. A trumpet-shaped tube, terminated by the anus.

Medulla, longitudinal, knotty; branchiæ external, sometimes concealed; circulation by a heart and vessels.

Shell multivalve, sessile, or elevated on a flexible, tendinous pedicle; valves unequal, sometimes moveable, sometimes fixed, covered internally by the mantle.

This class contains two orders:

1. Sessile Cirripeda.
2. Pedunculated Cirripeda.

* *Matted*, from *cespes*, a turf. † *Ancient*.

‡ From *cirrus*, a curl, and *pes*, a foot, signifying curled feet.

First Order.

Sessile Cirripeda.

Body without pedicles, enclosed in a shell, fixed immediately on marine substances. The mouth in the upper anterior part of the body.

There is a great difference in the shells of the sessile and the pedunculated cirripeda; the former are never compressed at the sides, generally appear to be formed of a single piece, like a cone, or tube truncated at the summit, and always have an operculum, composed of two or four moveable pieces, in their interior. The shell and its operculum are solid and calcareous. The shell of the pedunculated cirripeda, on the contrary, is always multivalve, and, in most of them, consists of five unequal pieces, forming, when not open, a cone laterally compressed. Some species have, besides, several small accessory pieces. Linnæus included both the orders in one genus, under the name of *lepas,* which Bruguière divided into two genera, *balanus* and *anatifa.* These genera answer to our two orders.

The first order contains six genera*.

1. Tubicinella†.

Body enclosed in a shell, on the upper part protrude small setaceous, cirrous, and unequal arms. Shell univalve, operculated, tubular, straight, rather attenuated towards the base, with annular transverse ribs; truncated at both ends, open at the summit, and closed at the base by a membrane. Operculum with four obtuse valves.

Type. *Tubicinella balænarum*‡, *adheres to the whales of the seas of South America.* Pl. iii. Fig. 9.

* Dr. Leach has given a short, but comprehensive, article in the *Supplement to the Encyclopædia Britannica,* on the Cirripeda. He divides them into two orders; 1. Campylosomata, from καμπυλον and σωμα, meaning a flexible body; and, 2. Acamptosomata, from ακαμπτον and σωμα, an inflexible body. The first order contains five genera, *viz.*, Otion, Cineras, Pentelasmis, Scalpellum, Pollicipes. The second order contains nine genera, *viz.*, Tubicinella, Coronula, Chelonobia, Pyrgoma, Creusia. Acasta, Balanus, Conia, and Clisia.—See *Ency. Brit. Sup.* Art. Cirripedes.

† From *tubicen*—a trumpeter. ‡ *Balæna,* a whale.

2. Coronula*.

Body sessile, enclosed in a shell, protruding small setaceous, cirrous arms, from the upper part. Shell sessile, apparently univalve; suborbicular, conoidal, or blunt conical; truncated at the extremities; sides very thick, hollowed into radiating cells. Operculum quadrivalve; valves obtuse. No annular transverse ribs.

Type. *Coronula diadema* †.

Shell ventricose, cylindrical, truncated; hexagonal, quadricostate; ribs longitudinal, transversely striated. Pl. iii. Fig. 10. 3 Species.

Adhere to whales, tortoises, &c.

3. Balanus‡.

Body sessile, enclosed in an operculated shell. Two rows of numerous, unequal, fringed arms, each composed of two cirri, supported on a pedicle, and extending beyond the operculum. Mouth not prominent; four transverse jaws, toothed, and besides four hairy palpiform appendages.

Shell sessile, fixed, conical, apex truncated; closed at the bottom by an adhering testaceous lamina. Aperture subtriangular, or elliptical. Operculum interior, quadrivalve; valves moveable, inserted near the inner base of the shells.

Type. *Balanus sulcatus*§.

Shell whitish, conical, longitudinally furrowed; furrows obtuse; ribs transversely striated.

Pl. iii. Fig. 11. 29 Species.

4. Acasta.

Animal........

Shell sessile, oval, subconical, composed of separable pieces. Cone formed of six lateral valves, unequal, united; at the bottom an orbicular lamina, concave on the inner side, resembling a little deep dish, or cup. Operculum quadrivalve. This shell

* From *corona*, a crown. † *Diadem.* ‡ *An acorn.*

§ *Furrowed.* Lamarck has given the *balanus angulosus* as the type of this genus, but no reference to any plate, or synonym. We have therefore thought it better to give the description and figure of the second species, *balanus sulcatus.* According to Lamarck, the two are nearly allied.

cannot stand on its base, which is externally convex, sometimes conoidal.

Type. *Acasta Montagui**.

Shell with acute valves, transversely striated, externally muricated, with small erect spines. 3 Species. *All found in sponges.* Pl. iii. Fig. 12.

5. Creusia.

Body sessile, subglobular, enclosed in an operculated shell. Several tentacula. Mouth not prominent, situated at the upper anterior part of the body.

Shell sessile, fixed, orbicular, conically convex, composed of four unequal, united valves, with distinct sutures. Operculum interior, bivalve. Shell generally very small, attached to madrepores, and other marine substances.

Type. *Creusia Stromia.*

Shell conico-convex; valves with radiated furrows; two serrated sutures. *North Seas.* 3 Species.

6. Pyrgoma.

Animal......

Shell sessile, univalve subglobular, ventricose, convex at the top, apex perforated. Aperture small, elliptical. Operculum bivalve.

1 Species. *Pyrgoma cancellata*†. Incased in a stony polyparium of the genus *Astrea.* Red Sea? Pl. iii. Fig. 13.

Second Order.

PEDUNCULATED CIRRIPEDA.

The body supported by a moveable, coriaceous, tubular pedicle, fixed on marine substances. The mouth nearly on the under side.

This order contains 4 genera.

1. Anatifa‡.

Body covered with a shell, and supported by a tubular, tendinous pedicle. Numerous long, unequal, articulated, fringed tentacula, projecting on one side, below the summit.

* *Montague's.* † *Cancellated—lattice-work.* ‡ From *unas,* a duck.

Shell laterally compressed; five valved; the valves contiguous, unequal; two on each side, the fifth, longer and narrower, on the back; the lower side valves largest.

Type. *Anatifa levis**. (*Lepas anatifera. Linn.*)

Shell compressed, smooth, tube pedicle-shaped, long, transversely wrinkled.—*European, and other seas.* 5 Species. Pl. iii. Fig. 14.

2. Pollicipes†.

Body covered with a shell, and supported by a tubular, tendinous pedicle. Many tentacula. Pedicle generally very short, frequently shagreened, scaly, rugose, and pretty stiff.

Shell multivalve, laterally compressed; valves almost contiguous, unequal, thirteen or more; lower side valves smallest.

Type. *Pollicipes cornucopia‡*. (*Lepas pollicipes. Gmel.*)

Pedicle short, coriaceous, squamose; shell composed of numerous smooth unequal valves. *Coast of La Mancha, Mediterranean,* &c. Pl. iii. Fig. 15. 3 Species.

3. Cineras.

Body pedunculated, wholly covered with a membranous tunicle, tumid above, with an anterior aperture below the summit. Numerous slender, articulated, fringed arms, projecting through the anterior aperture.

Shell composed of five testaceous, oblong, separate valves, not wholly covering the body; two on the sides of the aperture, the others dorsal. 1 Species. *Cineras vittata§*. *British Ocean.* Pl. iii. Fig. 16.

4. Otion.

Body pedunculated, wholly covered by a membranous tunicle, tumid above.

Two horn-shaped tubes, turned backwards, truncated, open at the extremity, and placed on the summit of the tunicle. A rather large lateral aperture, through which project numerous articulated fringed arms.

* *Smooth.* † *Pollex*, a thumb, or an inch, and *pes*, a foot.
‡ *Horn of plenty.* § *Banded.*

Shell composed of two testaceous, small, crescent-shaped valves, separate, and adhering near the lateral aperture.

Type. *Otion Cuvieri**. (*Lepas aurita. Linn.*)

Body and horns without spots. *South Seas.* Pl. iii. Fig. 17. 2 Species.

CLASS XI.

CONCHIFERA†.

Animals soft, inarticulate, always fixed in a bivalve shell; without head or eyes; mouth naked, concealed, not furnished with any hard parts; the whole body covered with a large mantle, forming two lamellar lobes; lamina often free, sometimes united before. Generation oviparous, without copulation.

Branchiæ external, situated on both sides, between the body and the mantle. Circulation simple; heart with only one ventricle. Some ganglia, various nerves, but no ganglionated medullary cord.

Shell always bivalve, wholly or partly covering the animal, sometimes free, sometimes fixed; the valves generally united on one side by a hinge, or a ligament. Shell sometimes increased by accessary testaceous pieces, not belonging to the valves.

Linnæus arranged all animals, without skeletons and articulated feet, in one enormous class, *vermes*, which he divided into five sections, *viz.*, *intestina, mollusca, testacea, lythophyta,* and *zoophyta.* His mollusca, as a section of the *vermes,* comprehended some true mollusca, all the radiaria, some annulata, and cirripeda, whilst other true mollusca were separated from them, because they have a shell. This bad arrangement still exists in the *Systema Naturæ.*

The two valves of a *conchiferum* are sometimes unequal, when the shell is said to be *inequivalve*; sometimes exactly alike in their general form and size, when it is called an *equivalve* shell.

The ligament of the valves is sometimes external, sometimes

* *Cuvier's.* † *Concha,* and *fero,* bearing shells with two valves.

internal; in either case it serves both to keep the valves together, and to open and shut them. If the ligament be external, it is extended when the shell is shut; and if the muscle, which keeps the valves closed, be relaxed, the mere elasticity of the ligament opens them. If, on the contrary, the ligament be internal, it is compressed when the shell is shut, but on the muscle, which keeps it so, relaxing, the elasticity of the compressed ligament serves to open it.

The conchifera have no internal shell; they are all aquatic, some living in fresh, others in salt, water. Most of them are free, some are fixed to marine bodies by their shell, and others by corneous filaments, to which the name of *byssus* has been appropriated.

This class contains nineteen families, and is divided into two orders, *viz.*, *Conchifera bimusculosa*, and *Conchifera unimusculosa.*

First Order.

Conchifera bimusculosa*.

The shell presents internally two separate and lateral muscular impressions.

This order contains thirteen genera, and is subdivided into four sections.

Section 1st.

Crassipedat†.

Mantle wholly or partly closed in front; foot thick, posterior; shell, when shut gaping, at the sides. This section contains four families.

1st Family.

Tubicolaria‡, (contains 6 genera.)

Shell either contained in a testaceous sheath, distinct from its valves, or incrusted wholly or partially in the sides of the sheath, or projecting beyond it. The conchifera of this family are borers, and bury themselves in stones, wood, and thick shells, but some remain in the sands.

* *Having two muscles.* † *Crassus* and *pes*, signifying thick-footed.

‡ *Tubus* and *colo*, signifying inhabiting tubes.

The tubicolaria, as well as the pholades, consist essentially of two similar, equal and regular valves, jointed like a hinge. In consequence of their having accessory pieces, but which do not properly belong to the valves, these shells have been mistaken for multivalves.

1. Aspergillum*.

Sheath tubular, testaceous, diminishing insensibly towards the anterior part, which is open; the other end larger, and club-shaped; near the club are two valves incrusted in the side of the tube; terminal disc of the club convex, pierced with sub-tubular holes, and a fissure in the centre.

Animal unknown.

It has been erroneously supposed that the aspergillum is fixed to rocks by its smaller end, which is necessarily open.

Type. *Aspergillum Javanum*†. (*Serpula penis. Linn.*)

Sheath smooth; posterior disc surrounded by a radiated frill. *Indian Ocean.* Pl. iii. Fig. 18. 4 Species.

2. Clavagella‡.

Case tubular, testaceous, attenuated, open at the fore part; the opposite extremity oval, club-shaped, rather compressed, with spinous tubes; one valve fixed in the side of the club, the other free in the tubes.

Type. *Clavagella echinata*§.

Club of the sheath ventricose, one side covered with tubular spines. Pl. iii. Fig. 19. *Grignon.* 4 Species, all fossil.

3. Fistulana‖.

Sheath tubular, generally testaceous, tumid, and closed posteriorly; anteriorly attenuated, open at the summit, containing a free bivalve shell; valves equal, and when closed gaping. Neither valve fixed to the side of the tube. In some instances they have a slight resemblance to the valves of a modiola.

Animal......protrudes at the fore part, or small end of the tube, two little calcareous pipes, each terminating in from five to eight funnel-shaped, semicorneous, or calcareous cups, piled one above the other.

* *A watering-pot.* † *Of Java.* ‡ *Clava*, a club. § *Prickly.*
‖ *Fistula*, a pipe.

Type. *Fistulana Clava**.

Sheath taper, club-shaped, straight; valves of the shell elongated, rather arched at the extremities. *Indian Seas.* 6 Species. Pl. iii. Fig. 20.

4. Septaria†.

Animal......

Tube testaceous, very long, gradually attenuated towards the fore part, divided internally by arched partitions, generally incomplete. Anterior extremity of the tube, terminated by two other slender tubes, not divided internally.

The septaria are little more than very large fistulana, and scarcely deserve to be made into a separate genus.

Type. *Septaria Arenaria‡.* (*Serpula polythalamia. Linn.*) *Indian Seas.* Pl. iii. Fig. 21.

5. Teredina §.

Sheath testaceous, tubular, cylindrical, closed at the posterior extremity, shewing the two valves of the shell; open at the fore part.

Type. *Teredina personata*‖.

Tube straight, taper, club-shaped, club by its sinuses, and small lobes resembling a larva. *Courtagnon.* Pl. iii. Fig. 22. 2 Species, both fossil.

6. Teredo ¶.

Animal very long, vermiform, covered with a testaceous tube, anteriorly protruding two short tubes, with two operculiferous bodies adhering to their sides, and, posteriorly, a short muscle, received in a bivalve shell, to which it is attached. It bores wood.

Tube testaceous, cylindrical, tortuous, open at both ends, not belonging to the shell, and covering the animal. Shell bivalve, situated posteriorly on the outside of the tube. Valves almost lozenge-shaped, concave.

The teredines do great mischief to ships, by boring their planks, &c.

* *Club.* † From *septum*, a division. ‡ *Of the sands.*
§ From *teredo*, as resembling it. ‖ *Masked.*
¶ τερηδών, a worm that bores wood.

Type. *Teredo navalis**. (*Idem. Linn.*)

Anteriorly furnished with two short, simple, palmulæ, terminated by an operculi-form callus. Pl. iv. Fig. 23. *Europe.* In timber, immersed in salt-water. 2 Species.

2d Family.

Pholadaria, (contains 2 Genera.)

No tubular sheath; shell furnished with accessary pieces not belonging to the valves, gaping anteriorly.

Formerly the pholades, balani, and chitones were considered as multivalve shells, and forming a separate division; it is now known however that all the pholades are equivalve and regular bivalves; that their valves are united by a hinge, and that consequently they all belong to the class *Conchifera.* But in addition to the two constant valves, these shells have other singular pieces, always smaller than the true valves, that must be considered as accessary, for their number varies according to the species. The ligament is external, but covered and concealed by the accessary pieces. The pholadaria are borers and bury themselves in stone, wood, and madreporic masses, or the sands, living solitarily.

1. Pholas †.

Animal inhabits a bivalve shell, which almost wholly covers its body; protrudes anteriorly two united tubes, often surrounded by a common skin, and, posteriorly, a foot, or short muscle, very thick, flattened at its extremity. No tubular sheath.

Shell generally thin, fragile, bivalve, equivalve, gaping at both sides, having different accessary pieces, either on the hinge, or below it. Lower or posterior edge of the valves curved outwards.

Type. *Pholus dactylus* ‡. (*Idem. Linn.*)

Shell elongated, posteriorly narrow-beaked, posterior ribs denticulated; anterior side not ribbed, extended.

European Seas. Pl. iv. Fig. 24. 9 Species.

* *Of the ships.*

† From φωλεος, *latibulum*, a burrow.

‡ *Date?*

2. Gastrochæna*.

Shell bivalve, equivalve, almost wedge-shaped, very gaping; anterior aperture very large, oval, oblique; hardly any posterior aperture. Hinge linear, marginal, toothless. No accessary valves.

Type. *Gastrochæna cuneiformis*†. *Pholas hians. Chemn.*

Shell wedge-shaped, thin, somewhat transparent; striæ of the valves transverse, arched.

Isle of France. Pl. iv. Fig. 25. 3 Species.

3d Family.

SOLENACEA. (3 Genera.)

Shell transversely elongated, no accessary pieces, gaping only at the lateral extremities. Ligament external.

The solenacea bury themselves in the sand, but do not perforate stone or wood.

1. Solen‡.

Shell bivalve, equivalve, transversely elongated, gaping at both ends; beaks very small, not projecting. Cardinal teeth small, varying in number, sometimes none, seldom diverging, more rarely inserted in little pits. Ligament external near the hinge.

Animal with a mantle, closed in front; protruding, at one extremity of the shell, a subcylindrical foot; and at the other a short tube, containing two tubes united.

The solens live on the sea-shore, burying themselves perpendicularly in the sand, sometimes to the depth of two feet, ascending and descending by means of the muscular foot, at the lower extremity of the shell.

Type. *Solen vagina*§. *Idem. Linn.*

Shell linear, straight; one end marginated, or thickened; one cardinal tooth in each valve. *European, American, and Indian Seas.* Pl. iv. Fig. 26. 21 Species.

2. Panopæa||.

Shell equivalve, transverse, unequally gaping at the sides.

* From γαστηρ, the belly, and χαινω, to gape. † *Wedge shaped.*

‡ Σωλην, a pipe, or tube. § *Sheath.*

|| Παν, omne, et οπαιον, foramen, indicating the great gaping of the shell.

One conical cardinal tooth in each valve, and near it a short, ascending, compressed callus, not projecting outwards. Ligament external, on the longer side of the shell, fixed on the calli.

The panopæa differs from the glycimeris, by having cardinal teeth, and by the ligament being on the longest side; from the solen, by the greater projection of the beaks, and from the mya, by the ligament being external.

1 Species. *Panopæa Aldrovandi**. (Mya Glycimeris. *Linn.*) *Mediterranean.* Pl. iv. Fig. 27. *Gmelin.*

3. Glycimeris.

Shell transverse, very gaping on both sides. Hinge callous. without teeth. Nymphæ projecting outwards. Ligament external.

The glycimeris differs from the solen and the saxicava, by having the ligament on the shortest side of the shell, and from the solen also further, by having no hinge tooth.

Type. *Glycimeris Siliqua†.*

Shell transversely oblong, epidermis black; nates eroded; valves internally thickened by a callous disc. Pl. iv. Fig. 28. *North Seas.* 3 Species.

4th Family.

MYARIA. (3 Genera.)

Ligament internal. One large spoon-shaped tooth, either on both valves, or only on one, to the cavity of which the ligament is attached. Shell gaping at one end, or at both.

1. Mya‡.

Shell bivalve, transverse, gaping at both ends. One large cardinal tooth on the left valve, compressed, broad, somewhat rounded, projecting almost vertically. A cardinal pit on the other valve. Ligament internal, short and thick, inserted in the projecting tooth, and the corresponding cavity of the opposite valve. Animal with a mantle, closed before, a short, compressed, and rather thick foot, at one extremity; at the other.

* Aldrovandus. † Bean pod. ‡ Μυς, a muscle.

protruding a large tube, containing two others, one to admit water, the other for the anus.

Linnæus confounded in one genus the mya and unio ; whereas, the latter is a fresh-water shell, and has a very different hinge from that of the mya. The myæ bury themselves in the sand.

Type. *Mya truncata**. *Idem Linn.*

Shell ovate, ventricose, anteriorly truncated; cardinal tooth very entire, rounded, projecting forward. *European Ocean.* Pl. iv. Fig. 29. 4 Species.

2. Anatina†.

Shell transverse, subequivalve, gaping at one or both sides. One naked, broad, spoon-shaped cardinal tooth, projecting internally in each valve, the hollows of which receive the ligament. Generally a lamina, or falciform rib, near the hinge teeth, and running obliquely below them.

The anatina differs from the mya, by having two spoon-shaped teeth, whilst the mya has but one.

Type. *Anatina lanterna*‡.

Shell ovate, very thin, pellucid, fragile, rounded on both sides. *Indian Ocean.* Pl. iv. Fig. 30. 10 Species.

Section II.

Tenuipeda§.

Lobes of the mantle scarcely or not at all united in front; foot small, compressed. Lateral gaping of the shell generally inconsiderable.

This section includes several of the conchifera, hitherto very confusedly arranged. Some were united to the solens, to which they seemed nearly allied, although the animal, especially in its foot, probably differs very much in form and proportion from the inhabitant of those shells. Others were placed with the myæ, tellinæ, and veneres, and a great number were still without any proper place being assignable to them amongst the existing genera. To get rid of this confusion, Lamarck

* *Truncated.* † From *anas,* a duck? ‡ *Lantern.* § *Slender-footed.*

divides the conchifera tenuipeda into the four families contained in this section.

1st Family.

Mactracea.

Foot of the animal small, compressed, and calculated for locomotion.

Shell equivalve, generally gaping at the lateral extremities. Ligament internal, with or without any external ligament.

1. Lutraria*.

Shell inequilateral, transverse oblong, or rounded, gaping at the lateral extremities. Hinge with one tooth, folded, as it were into two, or two teeth, one simple, with an adjacent, oblique, deltoid pit, projecting inwards. No lateral teeth.

Ligament internal, fixed in the pits.

The lutrariæ are distinguished from the mactræ by having no lateral teeth. The hinge presents on each valve a compressed protuberance, hollowed above, into a pit, and on one side, one or two teeth, one of them folded, as it were, in two, the other simple.

Type. *Lutraria solenoides*†. Mya oblonga. *Gmelin.*

Shell oblong, with transverse rugose striæ; anterior side very long, apex rounded, very gaping.

European Ocean. Pl. iv. Fig. 31. 12 Species.

[To be continued.]

Art. VII. *Experiments on the Oxides and Salts of Uranium.*

It is generally stated, upon the authority of Bucholz and Schoubert, that there are two oxides of uranium, but the following experiments appear to render this opinion very doubtful.

A quantity of oxide of uranium was prepared, as usual, from the *native oxide* (pechblende), and converted into *nitrate*, by solution in nitric acid and crystallization. The crystals were dissolved in water, and were found still slightly contaminated

* *Lutra*, an otter, from *lutum*, mud, because it frequents muddy places.

† *Solen-like.*

by copper, their solution was therefore decomposed by excess of ammonia, and the precipitated oxide digested in liquid ammonia, until all traces of copper were removed; it was then washed, and dried in a very moderate heat, and was considered as a pure hydrated *peroxide* of uranium.

But this supposed peroxide dissolved very readily in muriatic acid, without the slightest evolution of chlorine, though there was some effervescence arising from the extrication of a small portion of carbonic acid gas. Moreover, the above hydrated oxide, when heated to dull redness in a glass tube, only lost water and a little carbonic acid; it lost no oxygen, but became black and cohesive, diminishing exceedingly in bulk. A portion heated to bright redness in a platinum crucible, underwent nearly the same changes, contracting into a dark purplish mass, which, however, when triturated into an impalpable powder in an agate mortar, assumed a dingy yellow-brown tint. In this state the oxide of uranium appears only to lose water and a small portion of carbonic acid, accidentally contracted during its precipitation and drying, and not to have altered its state of oxidation, for it remains as before, perfectly soluble in muriatic and nitric acids, evolving no gas, and forming salts in no respect differing from those produced with the hydrated oxide, recently thrown down from the nitrate.

50 grs. of the yellow hydrated oxide of uranium, dried at 212° and afterwards exposed under the exhausted receiver including a surface of sulphuric acid, till it no longer lost weight, were exposed to a white heat, in a platinum capsule. The loss, upon an average of three trials, amounted to 6 grains, so that the composition of the hydrated oxide of uranium is—

88	oxide
12	water
100	

and, assuming this hydrate to consist of 1 proportional of water and 1 of oxide, the prime equivalent of oxide of uranium will be 66, that of water being 9; and 58 will be the equivalent of uranium, if the above oxide be a compound of 1 proportional of metal and 1 of oxygen.

II. Oxide of uranium dissolves easily and entirely in muriatic acid, and the solution affords, on evaporation, very deliquescent prismatic crystals, of an olive-green colour; if these be dried by heat, they suffer decomposition; but when dried in the exhausted receiver, by sulphuric acid, they crumbled down into a dirty green powder, which is extremely deliquescent. To ascertain the composition of this salt, a portion of the neutral muriate was decomposed by caustic ammonia, and the precipitated oxide dried, ignited, and weighed, amounted to 112 grains. The filtered ammonio-muriatic solution was rendered slightly acid by nitric acid, and precipitated by nitrate of silver; it afforded 149.8 grains of chloride of silver, equal to 38 grains of muriatic acid. Here, therefore, the muriate of uranium appears to consist of—

Oxide of uranium .	112 . .	100
Muriatic acid . .	38 . .	34

Assuming this muriate to consist of 1 proportional of muriatic acid, =37, and 1 of oxide of uranium, the equivalent of the latter will be 109, and that of the metal 101.

III. The recently precipitated oxide of uranium very readily dissolves in nitric acid, and, by careful evaporation, furnishes truncated prismatic crystals of a peculiar iridescent appearance, a brownish-yellow colour, and deliquescent. A portion of these crystals, exposed under the exhausted receiver containing sulphuric acid, effloresced into a yellow powder, which was retained in vacuo till it ceased to lose weight; 60 grains were then submitted to a red heat, in a platinum capsule, and 36.4 grains of oxide remained. If, therefore, we regard the above salt as a dry nitrate, it will consist of

36.4	oxide of uranium	=60.7
23.6	nitric acid . .	=39.3
		100.

and if considered as a compound of 1 proportional of nitric acid, and 1 of oxide of uranium, the number 84 will represent the oxide, and 76 the metal; but we can put no further reliance in the above numbers than as showing the quantity of oxide

in the nitrate, dried as above described, for it is probable that in that state the salt still retains a portion of water, which would vitiate the above estimate.

IV. When recently precipitated oxide of uranium is digested in sulphuric acid, diluted with 4 or 5 parts of water, a solution of a green colour is obtained, which has an astringent aluminous taste, and is neutral; but, when evaporated, it deposits successive crusts of a difficultly soluble green salt, probably a subsulphate of uranium, and the supernatant liquor becomes acid, but cannot be made to crystallize.

Dilute sulphuric acid was digested upon moist oxide of uranium, until a perfectly neutral solution was obtained. A portion of this solution was decomposed by caustic ammonia, and the precipitated oxide, duly washed and ignited, weighed 62 grains. The solution from which the above 62 grains of oxide had been thrown down was neutralized by nitric acid, and precipitated by muriate of baryta. It yielded 85 grains of dry sulphate of baryta, which is equivalent to 22 grains of sulphuric acid; here, therefore, it would appear that dry sulphate of uranium consists of

62	oxide	=	68.1
29	acid		31.9
91			100.

and, assuming 40 as the prime equivalent of sulphuric acid, that of oxide of uranium will be 85.6, and of the metal 77.6, a number not very different from that obtained by the analysis of the nitrate.

V. When solution of nitrate of uranium is decomposed by carbonate of ammonia, a very slight excess of the latter dissolves a considerable portion of the precipitate, and which, when collected and dried, appears to retain the carbonic acid very feebly, and not to be of uniform composition, but a mixture of oxide and carbonate. In several experiments, in which the supposed carbonate of uranium was decomposed by muriatic acid over mercury, the proportion of carbonic acid evolved was various. The following is the best experiment that was made with the precipitated carbonate: 30 grains were decomposed over mercury, by muriatic acid; they evolved 2.9 cubic inches of carbonic

acid = 1.32 grains; 30 grains of the above carbonate, heated to redness, until they ceased to lose weight, lost 3.4 grains. Hence it appears, that 30 grains of the above precipitated carbonate consist of

Oxide	26.6
Acid	1.32
Water	2.08

a quantity of carbonic acid infinitely too small to be considered as saturating the oxide.

Another attempt was made to obtain a pure carbonate of uranium. A quantity of recently precipitated and moist oxide was diffused through water, and carbonic acid was passed through the mixture, by which the oxide was very soon entirely dissolved. This solution was gently heated, when it presently became turbid, and the precipitate being collected and dried at a very moderate heat, was of a dirty yellow colour, and perfectly soluble, with *slight* effervescence, in muriatic and nitric acids. When, however, an attempt was made to collect the carbonic acid evolved, it did not amount to 1 cubical inch from 30 grains; so that it may perhaps be concluded that there is no dry carbonate of uranium which can be regarded as a definite compound.

VI. It has been stated above, that when oxide of uranium is boiled with dilute sulphuric acid, a yellow-green compound, of difficult solubility, is formed, which has there been termed a subsulphate; to determine its composition, 50 grains, carefully washed and dried, were dissolved in nitro-muriatic acid, and the solution decomposed by ammonia; the precipitated oxide of uranium having been separated upon a filter, the clear liquor was precipitated by muriate of baryta, and 29.5 grains of sulphate of baryta, = 10 of sulphuric acid, were obtained; hence the composition of the subsulphate is,

Sulphuric acid . .	10.
Oxide	40.
	50.

and if we consider this as composed of 2 proportionals of oxide

and 1 of acid, we obtain the number 80 as the equivalent of oxide of uranium, and 72 as that of the metal. Neither iodine nor the hydriodates occasion any precipitation in solutions of uranium, but ferrocyanate of potassa occasions a fine reddish-brown precipitate in them all, and this although they are considerably acid.

The above experiments were undertaken with a view of determining the equivalent number of uranium; but, of the various compounds that have been examined, the sulphates only appear to afford results that can be deemed at all satisfactory; and even these are too much at variance to enable us to assume their analyses as the foundation of a prime equivalent number.

Art. VIII. *A Review of some of the General Principles of Physiology, with the Practical Results to which they have led.* By A. P. W. Philip, M. D., F. R. S. Edinb.

[Concluded from page 276, Vol. XIII.]

We have now taken a rapid survey of the general laws of the muscular and nervous systems, and the means by which these laws have been ascertained. The power of the muscles we found independent of the influence of the nervous system, which stands in no other relation to them, but that of a stimulus. This power appears, from what has been said, to be of the same nature in all muscles; the means of exciting it alone varying in those of voluntary and involuntary motion. The nervous system, we have seen, besides affording the sole stimulus of the former and an occasional stimulus of the latter set of muscles, maintains, by its action on the blood, the secreting and other assimilating processes, and the due temperature of the animal, and is the means of conveying impressions to and from its more central parts, the brain and spinal marrow; there being no evidence that impressions are ever communicated from one nerve to another, independently of the intervention of one of these organs: a position farther illustrated by the able investigations

of Mr. Charles Bell, which have afforded new and important views of the distribution and uses of certain nerves *.

A set of functions still remains to be considered, which will, I think, be found equally distinct from those of the muscular and nervous systems, although they have never been correctly distinguished from the latter †. I allude to the sensorial functions, the maintenance of which seems to be the final cause of both the others. The functions of the muscular and nervous powers maintain the life and health of the animal, and are the immediate means of intercourse between it and the external world; by those of the sensorial power it is rendered capable of enjoyment. Were this, however, the only object of that power, it would not fall under the scope of the present paper, in which it is proposed to consider the vital powers alone. But on minute inquiry into the relation which the various functions of the more perfect animals bear to each other, it will appear that the sensorial functions are necessary to the existence of the rest. It is only, as was stated at the beginning of this paper, in as far as they are so, that we are here to consider them.

The first observation which strikes us on comparing the nervous functions, which we have been considering, with those termed sensorial, is that the former bear a striking, the latter no, analogy to the effects observed in inanimate nature. The excitement of the muscular fibre, the act of secretion, and the maintenance of animal temperature, bear a striking analogy to the processes of the laboratory, and the transmission of impressions through the nerves, both to chemical and mechanical processes; but what analogy can we detect between the functions of the sensorial power, sensation and volition, for example, and such processes. We are now in a new world, and we at once

* *Philosophical Transactions* for 1821.

† The circumstance of the sensorial and nervous functions having never been accurately distinguished, appears to have been a principal cause of the nature of the latter being involved in so much obscurity.

The term vital principle has been used with so little precision, that I must beg the reader to keep in view the definition of it given in the commencement of this paper.

perceive, that it is in vain to look for the analogies which necessarily suggest themselves on reviewing the phenomena of the nervous and muscular systems. It seems to require but a moment's reflection to teach every sober and unprepossessed understanding, that, in our study of the sensorial power, we must be satisfied with observing and arranging its phenomena without attempting to refer them to any more general principle.

What I am about to say of this power may be divided into two parts. In the first, I shall attempt by the aid of experiment, to draw a correct line of distinction between the sensorial and nervous functions; and in the second, by the same means, to trace the manner in which the former are so connected with both the nervous and muscular functions, as to render them essential to the continuance of life in the more perfect animals.

However blended the organs of the sensorial and nervous powers may appear to be, we are assured that they are distinct organs, by the fact, that while the organs of the nervous power evidently reside equally in the brain and spinal marrow, those of the sensorial power appear to be almost wholly in man, and chiefly, in all the more perfect animals, confined to the former. It may be possible, therefore, to withdraw the power on which the one set of functions depends, without immediately destroying the other, as we find we can withdraw the influence of the nervous from the muscular system without destroying the power of the latter.

At the instant of death, it is evident that the sensorial functions cease. No impression is perceived, or followed by any act of volition. It is, however, equally evident to the physiologist, that the muscular power still remains. If, under these circumstances, the heart or muscles of voluntary motion be stimulated, they still possess the power of contraction, which is only lost by degrees, and not till after the sensorial power has for a considerable time been withdrawn. It is also evident to the physiologist, that some part of the nervous power still exists; for, if the nerves themselves, or those parts of the brain or spinal marrow from which they originate, be irritated, the corresponding muscles are thrown into action. The nerves, therefore, are still capable both

of conveying impressions and exciting the muscles. Are they capable of their other functions? Can they effect the formation of the secreted fluids, and raise the temperature of the blood, after the sensorial power is withdrawn?

It is, perhaps, superfluous to observe, that the erosion of the stomach by the gastric fluid after death, first observed by Mr. Hunter, is not to be regarded as a vital action, but as a mere chemical process; Mr. Hunter, however, it appears from what he says in the hundred and eightieth page of his Observations on the Animal Economy, suspected that a truly vital action, a continuance of the secreting process, goes on in the stomach for some time after what is called death.

It appeared to me, that this opinion might be reduced to the test of experiment by dividing, immediately after death, the eighth pair of nerves in the neck. I shall use the words death and kill in the usual acceptation, not implying the ceasing of all the functions. After this explanation, no ambiguity can arise from the use of these terms. We are not, it is evident, to expect that any great secretion of gastric fluid can take place after death; or, consequently, that any great difference can be observed between the food in the stomach of an animal in which the eighth pair of nerves has been divided immediately after death, and one in which they are left entire; and many circumstances which we cannot estimate, particularly there being more gastric fluid in the stomach of the one animal than the other at the time they are killed, or one having eaten more than the other, must influence the result. It will not answer the purpose, it is evident, to confine the animals to the same quantity of food, because the stomach of that which is most hungry contains most gastric fluid. The quantity of old food in the stomach also influences the result. The question, therefore, can only be determined by making the experiment on a large scale, to which there can be no objection, as the examination only takes place in the dead animal.

By such an experiment* it was ascertained that the secretion of gastric fluid continues for a certain time after death.

* *Inquiry*, Exper. 61.

It is vulgarly supposed, and there is good reason to believe, that both the nails and hair continue to grow after death. The experiment just referred to, at the same time that it shews the continuance of the function of secretion after the sensorial power has ceased to operate, shews, more than any experiment on the living animal could do, how quickly the secretion of gastric fluid is destroyed by interrupting the influence of the brain.

It is remarkable, that the division of the eighth pair of nerves in the neck, immediately after death, almost always produces the same appearance of dark-coloured patches in the lungs, though usually in a less degree observed when the operation has been performed during the life of the animal. These patches now and then appear in the lungs of an animal whose nerves are entire, after it has lain dead for some time; but much less frequently, and to a much less degree, than when the nerves have been divided immediately after death*.

In considering the result of the experiment just referred to, the question arises, what occasions any supply of fluids to secreting surfaces, after the circulation has ceased, and thus enables the remaining nervous influence to produce any secreted fluid after death? A ready answer to this question is afforded by experiments made on the newly dead animal †, from which it appears that the blood continues to be carried on in the capillaries of a full grown rabbit for at least an hour and a half, probably much longer, after death. That part of the circulation which is performed by the capillaries appears to continue, particularly in internal parts, which lose their temperature slowly as long as any considerable supply of blood can be obtained ‡. Hence it seems to be, that the larger arteries of animals which have been dead for some time, are generally found empty. How readily the continued action of the smaller arteries must empty them will be evident, when we recollect that at every division

* *Inquiry*, Exper. 61. † *Inquiry*, Exper. 62, 63.

‡ Haller has shewn, that the motion of the blood continues in the capillaries, when they are no longer influenced by the power of the larger arteries.

the sum of the areas of the branches of arteries exceeds that of the trunks. We may thus account for the supply of fluids to secreting surfaces, and for a certain power of the nervous system remaining after death; and when the *vis à tergo* has wholly ceased, except as far as it depends on mere elasticity, and the action of very small vessels.

It remains to be ascertained, whether the nervous power is capable of raising the temperature of the blood after the sensorial power is withdrawn. The maintenance of the temperature of the more perfect animals, seems, from facts already referred to, so immediately to depend on the state of the circulation, and to be so generally proportioned to its vigour, that we cannot, I think, adopt a better means of answering the question before us, than by ascertaining, whether supporting the circulation by artificial respiration after death occasions the dead animal to assume more slowly the temperature of the surrounding medium. On this subject there has been considerable difference of opinion. The 64th and two following experiments of the above-mentioned Inquiry seem to point out how this difference may have arisen on the supposition that all the experiments which have been made on the subject are correct, which we have every reason to believe them to be. It is evident, that all the air thrown into the lungs beyond what is necessary to effect the proper change on the blood must tend to reduce the temperature, in proportion as that of the air is less than that of the animal. The living animal receives but little air into the lungs at each inspiration, and it is impossible, after death, just to throw in the quantity which the blood still requires, and no more.

It appears from the experiments last mentioned, that when the lungs were inflated from twenty-five to thirty times in a minute, the inflation acted as a cooling process; but that when they were inflated only ten or twelve times, the animal cooled more slowly than another under the same circumstances left undisturbed: and what particularly points out that artificial respiration tended in these experiments to maintain the temperature is, that when it was employed, the temperature was sometimes found to have risen (in one instance nearly a whole degree,) between the

times of examination; whereas in the undisturbed animal it abated uniformly. I speak with the more certainty of the result of these experiments, because while I was making them in Worcester, Dr. Hastings, without my knowledge, was making similar experiments at Edinburgh. He has shewn me the detail of several, from which it appears that throwing air into the lungs of the dead rabbit about fifteen times in a minute, occasions it to cool more slowly. In one of his experiments, so great was the effect, that while the rabbit, which was left undisturbed, cooled 7.5°, that which was subjected to artificial respiration, cooled only 4°. He also frequently saw the thermometer rise a little in those animals in which the lungs were inflated after death. In those in which they were not inflated, the cooling was uniform.

Thus it appears that the nervous as well as the muscular power is capable of performing its functions after the sensorial power is withdrawn. That power, like the muscular, therefore, has no direct dependence on the sensorial power. It remains for us to inquire whence it arises that neither of these powers ever long survive the sensorial power.

On the sensorial power being withdrawn, respiration always ceases. M. le Gallois finds a great difficulty in explaining why respiration should cease on the removal of the brain.

" Il est donc certain que la vie de tronc n'a son principe immédiat ni dans le cerveau, ni dans aucun des viscères de la poitrine et de l'abdomen ; mais il ne l'est pas moins, que tous ces viscères sont indispensables à son entretien. Or, en considérant sous quel rapport ils le sont, les faits énoncés plus haut prouvent évidemment que, quant au cerveau, les phénomènes mécaniques de la respiration, c'est-à-dire, les mouvemens par lesquels l'animal fait entrer l'air dans ses poumons, dépendent immédiatement de ce viscère. Ainsi c'est principalement en tant que l'entretien de la vie dépend de la réspiration qu'il dépend du cerveau; ce qui donne lieu à une grande difficulte. Les nerfs diaphragmatiques, et tous les autres nerfs des muscles qui serve aux phénomènes mécaniques de la réspiration, prennent naissance dans la moëlle épinière, de la même manière

que ceux de tous les autres muscles de tronc. Comment se fait-il donc qu'après le décapitation, les seuls mouvemens inspiratoires soient anéantis, et que les autres subsistent? C'est là à mon sens, un des grands mystères de la puissance nerveuse; mystère qui sera dévoilé tôt ou tard, et donc la découverte jettera la plus vive lumière sur le mécanisme des fonctions de cette merveilleuse puissance."

This difficulty appears to me to arise from M. le Gallois's having regarded respiration as a function wholly dependent on a combination of the nervous and muscular powers; whereas it seems evident, I think, that the sensorial power also shares in it. The muscles of respiration are, in the strictest sense, muscles of voluntary motion; we can at pleasure interrupt, renew, accelerate, or retard their action; and if we cannot wholly prevent it, it is for the same reason that we cannot prevent the action of the muscles of the arm, when fire is applied to the fingers. The pain, occasioned by the interruption of a supply of air to the lungs, is greater than can be voluntarily borne. Respiration continues in sleep for the same reason that we turn ourselves in sleep when our posture becomes uneasy. It continues in apoplexy for the same reason that the patient generally moves his limbs if they are violently irritated. If respiration continues in apoplexy when no irritation of the limbs, however violent, excites the patient to move them, it arises from the interruption of a supply of air to the lungs producing a greater degree of irritation than we are able to produce by other means. As the insensibility increases in apoplexy, the breathing becomes less frequent; and when the former becomes such that no means can longer excite any degree of feeling, the breathing ceases.

By a certain sensation a desire is excited to expand the chest. This is an act of the sensorium. Till this act take place, both the nervous and muscular powers, by which its expansion is effected, are inert; it is in vain that these powers exist, if the power which calls them into action be lost. Thus the removal of the brain puts a stop to respiration.

Is it said that the motions of respiration must be involuntary, because we are in general unconscious of them? but do we not

become more or less so of all habitual acts of volition? We frequently hear such observations as the following:—if I did so, I did it unconsciously. If we stop a person who is walking, he cannot tell which leg he last moved; or a person who is playing on an instrument, he cannot tell which fingers he last employed; yet all such acts are strictly acts of volition. If we are reminded of them, we can always interrupt, renew, retard, or accelerate, them at pleasure. We have no difficulty in perceiving and changing in any way we please the motions of respiration when we choose to attend to them; but as there is no other act of volition so habitual, there is none so apt to escape attention.

The above explanation of the manner in which the removal of the brain puts a stop to respiration will be readily admitted, I think, when we consider to what part of the brain impressions from the lungs are conveyed. It is evidently to the part where the eighth pair of nerves, which supplies them, joins that part of the brain from which the spinal marrow originates. These nerves are no ways connected with the intercostal muscles, and diaphragm; yet it appears from the experiments in which M. le Gallois removed the brain by slices, that respiration continued till he removed the origin of these nerves, and then instantly ceased. In these experiments the power of the muscles of respiration, and the nervous power which excites them, still remain, as may be easily ascertained by stimuli properly applied to the spinal marrow; hence M. le Gallois's difficulty. It is the sensorial power alone, the sensation which induces us to inspire, that is lost.

We cannot, perhaps, have a better instance of the distinct operation of the sensorial, nervous and muscular powers, than in the case before us, although they all here conduce to the same end. We may destroy any one of them, and leave the others unimpaired. The destruction of the sensation, in consequence of which we will to inspire, we have just seen, neither destroys the nervous nor muscular power employed in expanding the chest. By means applied to the muscles of respiration, we may destroy their contractility without destroying any part of the nervous power, or at all impairing the sensation just mentioned; and we may destroy the nervous power which excites these muscles

by destroying a certain part of the spinal marrow, while they, as may be ascertained by the application of stimuli, perfectly retain their vigour, and the sensation which excites the wish to inspire, though as in the last case useless, remains unimpaired. If even any two of these powers be destroyed, they leave the one which remains entire. The destruction of the muscles of respiration, and of the nervous influence which excites them, does not destroy the sensation by which we will to inspire; nor does the destruction of this sensation, together with that of the nervous influence, at all impair the power of the muscles of respiration, provided they are not exhausted by the means employed for these purposes. And we may destroy the sensation in question, and the power of the muscles, without impairing the nervous influence which excites them. So far from correct is the position of M. le Gallois, that the powers on which all the motions of inspiration depend reside in the *medulla oblongata.*

Much has been written by Whytt, and other physiologists, respecting the cause of the first inspiration. I cannot help thinking that the difficulty vanishes when we regard the muscles of inspiration as merely muscles of voluntary motion. The young animal throws them into action to remove a painful sensation occasioned by the want of that change in the blood which is produced by the influence of the air in the lungs; a process necessary to its existence as soon as its connexion with the mother ceases, and which can only be effected by expanding the chest, and thus receiving air into the lungs. It seems to be expanded for the first time precisely for the same reason that the fœtus changes its position for the first time by acting with the muscles of the trunk and limbs. In both cases it endeavours to remove an uneasy sensation, and nature has given it the power to remove it by calling into action certain muscles subjected to the will. The first act of deglutition, if it does not occur in the fœtal state, appears to be an act of precisely the same nature with the first inspiration. In both cases a certain set of muscles of voluntary motion is thrown into action to satisfy a craving which had no existence in that state.

It may be objected to this view of the cause of the first inspiration, that the animal often breathes before a ligature is thrown

around the umbilical cord. But we have no reason to believe that the secondary change effected in the blood of the fœtus by the vicinity of the maternal blood of the placenta, (although this gives it the florid colour, as may be seen by opening the vessels of the chord,) is sufficient for the functions of the perfect animal. One of these functions, which we have just seen, we have reason to believe from many phenomena, as well as from direct experiments, to be intimately connected with the change effected on the blood by the air, the maintenance of the due temperature, it is evident, is immediately after birth required to be in a state of much greater activity than in the fœtus, which is surrounded by a medium of its own temperature.

When respiration ceases, most of the pulmonary vessels, and left side of the heart, are no longer supplied with their proper stimulus, and feel more directly, perhaps, the debilitating influence of black blood*. Their functions, therefore, begin to fail, and in proportion as this happens the blood accumulates in the lungs, and the right side of the heart consequently experiences

* Bichat has been at great pains to ascertain the effects of black blood on the lungs, and other organs. To his experiments I refer the reader. There are but few parts of the physiological works of Bichat which can be confidently referred to. In general he has allowed his reasonings to go far beyond the evidence afforded by his observations and experiments. I shall take this opportunity of making a few remarks relating to the principal points in which I have differed from him. He was unacquainted with the fact, that the spinal marrow can perform its functions independently of the brain, and therefore did not see the difficulty respecting respiration stated by M. le Gallois, but seems to think that the division of the spinal marrow near the head occasions death by preventing the nervous influence of the brain from reaching the intercostal muscles and diaphragm. The want of this knowledge leads him into inaccuracies, both in his observations on death, and other passages; which are increased by his not being aware that the sensorial and nervous powers have no direct dependence on each other. He is led into more obvious errors, as far as I am capable of judging, in various parts of his works, particularly in those which relate to the passions and the death of the brain, by his not knowing that the heart and blood vessels may be directly influenced, and even their power directly destroyed by agents acting either on the brain or spinal marrow; and by his supposing that the ganglions are capable of preparing nervous influence independently of the brain and spinal marrow, a supposition which we have seen

an increasing difficulty in emptying itself. By the operation of these causes, both sides of the heart in warm-blooded animals soon lose their power after respiration ceases. The arteries under such circumstances, it is evident, cannot long supply fluids proper for the purposes of assimilation. The nervous and muscular solids, therefore, soon deviate from the state necessary for the functions of life, which at length cease in every part.

Such seems to be the order in which the functions always cease in death, whether it be occasioned by injury of the sanguiferous or nervous system, or both, with the exception of the cases above-mentioned, in which the sensorial or nervous system is so impressed as immediately to destroy all the functions. From which it appears that the degree of vital energy required for the sensorial, is greater than that required for the nervous and muscular, functions; the cause of which we shall presently have occasion to consider. Respiration, consequently, is the first vital function which fails, being the only one to which the sensorial power is necessary.

contradicted by many experiments, and which Bichat does not attempt to support by any observation or experiment directly bearing on the point.

These circumstances have led him into the most striking inconsistencies in his great division of the functions into organic and animal. If the experiments which have been laid before the reader be correct, the sensorial functions constitute the animal, and the nervous and muscular the organic life. To this it may be objected that the less perfect animals and plants appear to have no nervous system. Would it not be more correct to say that the operation of their nervous system is more confined? Wherever secretion is performed, the nervous influence, or a power resembling it, must exist. In order that a being possessed of the nervous and muscular systems alone, may live in perfect vigour, it is only necessary that respiration should be performed, as circulation is by powers of involuntary motion. A being so formed, though possessed of all the powers of life, would be wholly unconnected with the external world, except as far as food and the influence of air and light are necessary to its existence; yet in the second section of his sixth article, Bichat maintains that the passions belong to the organic life, an inconsistency which alone sufficiently evinces a radical defect in his system. Can the passions belong to that life in which they never could be excited? "Even according to Bichat's definition of organic life, it is common to the animal and vegetable world!

We have now taken a view of the phenomena of the various powers of the animal body necessary to the preservation of life. As we have found the muscular independent of the nervous power, yet influenced by it, we have found the nervous independent of the sensorial power, yet in like manner influenced by it; we can withdraw the sensorial without destroying the nervous power, as we can withdraw the nervous without destroying the muscular power; but in the entire animal, as the muscular obeys the nervous, the nervous obeys the sensorial power, and they are all so connected that the existence of each indirectly depends on that of the others.

On the analogy which exists between the contraction of the muscular fibre and the coagulation of certain fluids, I have already had occasion to make some observations. Can we refer the phenomena of the sensorial and nervous powers to any more general principle?

As the properties of the vital principle do not differ from those of inanimate matter merely in degree or by any other modification, but have nothing in common with them, it follows, that when parts endowed with this principle affect each other only by their vital properties, the result must be such as bears no analogy to any of the properties of inanimate matter; and, consequently, that in all processes which have any such analogy, one of the agents must operate by the properties of this matter. We have seen that the characteristic difference in the sensorial and nervous functions is, that the former bear no analogy, the latter a very striking one, to those properties. On the other hand, we see the organs of the nervous system impressed by external objects, those of the sensorial system only through other vital parts. The nervous system is evidently the connecting link between the sensorium and the world which surrounds us. It consists of parts endowed with the vital principle, yet capable of acting in concert with inanimate matter; receiving impressions from it, and if the position just stated be correct, capable of impressing it; for there can be no stronger analogy than that which subsists between the secreting processes effected by the influence

of the nervous system, and the chemical processes which take place in such matter; and if an inanimate agent be employed in these processes, its supply and application must be regulated by the vital powers of the nervous system. Whether this agent be a distinct being, or only a peculiar modification of the particles of bodies, is not the question; all the essential inferences are, in either case, the same. The phenomena of electric animals are here in point. We see their nervous system collecting and applying, even according to the dictates of the will, an inanimate agent.

While these observations point out the necessity of limiting our study of the sensorial functions to a careful observation and arrangement of their phenomena, they encourage us to inquire into the nature of the functions of the nervous power; that is, to endeavour to refer them to some more general law, whose phenomena, however modified, are not wholly changed by one of the agents in these functions being endowed with the vital principle.

The power which operates in many other instances may be the means of exciting the muscles, of conveying impressions to and from the sensorium, of effecting the formation of the secreted fluids, and of maintaining the temperature of the animal body. The most subtile of known agents, electricity, naturally suggests itself, and when voltaic electricity and its signal influence on the muscular system were discovered, a material step, it was imagined, had been made towards ascertaining the nature of the nervous power. On more mature reflection, however, it was admitted, that to ascertain that galvanism is capable of exciting the muscular fibre, is to go but a very short way towards establishing its agency in the phenomena of the nervous system, a very large proportion of bodies possessing the same property; and of late the opinion appears to have been abandoned; nor can it be maintained on any other grounds than by showing that this species of electricity is capable of the more characteristic, as well as the more simple, functions of that system. On comparing the properties of galvanism with the phenomena of the nervous system, the analogy between them seemed to me to warrant the investigation thus suggested.

We have seen that by dividing the eighth pair of nerves in the neck, and displacing the divided ends, the power of digestion, and consequently the secretion of gastric fluid, is destroyed, and the function of the lungs deranged. This appeared to offer an excellent opportunity of ascertaining how far galvanism is capable of some of the more complicated functions of the nervous power. It is not difficult, by coating the lower part of the divided nerves with tin foil, and applying a small plate of metal to the skin over the stomach and lungs, to expose these organs by means of a voltaic pile to any degree of galvanic power which may be judged proper.

This was done both in granivorous and carnivorous animals *, and in both the functions of the stomach and lungs were restored by the presence of the galvanic influence. We cannot distinguish the effect in either instance from the healthy function.

It appears, from what was said above, that the division of the nerves not only deranges the secreting power of the lungs, but from their peculiar texture occasions, in the space of a few hours, evident deviations from their healthy structure. If, however, the application of the galvanism be made as soon as the division of the nerves takes place, and maintained with sufficient force, but not so long nor with such force as to excite inflammation, the structure as well as the function of the lungs continues unimpaired; thus proving that galvanism may be substituted for the influence of the nervous system in all the processes of assimilation.

The functions of this system we have seen are to excite the muscles, to convey impressions to and from the sensorium, to effect the formation of the secreted fluids, and other processes of assimilation, and to maintain the temperature of the animal body. Galvanism has long been admitted to be the best of all artificial stimuli of the muscles, and capable, in either direction, of passing along the nerves; and, it may be observed, better adapted to the excitement of the muscles when the positive than when the negative end of the pile is connected with the brain. The experiments just referred to prove it to be capable of effect-

* Expr. Inq. Exp. 70, 71, 72, 73. *Philosophical Transactions* for the present year. *Journal of the Royal Institut.* No. 22, 23.

ing the formation of the secreted fluids, and other processes of assimilation, when duly applied to the proper parts, while they retain the vital principle. It remains to inquire whether it can raise the temperature of living arterial blood; that is, living blood which has not already undergone the effects of the influence of the nervous system.

That it is capable of this function appears from the 77th and 79th experiments related in the above-mentioned Inquiry. The rise of temperature was immediate and considerable in one experiment 3°, in another 4°. From the 76th and 78th experiments it appears that galvanism has no power to raise the temperature of arterial blood after it has been exposed even for the short period of a minute and a half. It is necessary that the galvanism should act on it as it flows from the vessels, possessing all its vital properties. From the 80th, 81st, and 82d experiments, it appears that galvanism has no power to raise the temperature of venous blood; that is, blood which has already undergone the effects of the nervous influence, although applied to it immediately on its leaving the vessels.

In the seventh volume of the *Medico-Chirurgical Transactions*, Mr. Henry Earle notices cases of palsy, in which the temperature of the paralytic limb, although the pulse was good, was lower than that of the rest of the body. In one of them the electric influence was passed through the limb, and was found to raise its temperature *.

But raising the temperature of the blood seems not to be the only effect of galvanism on this fluid, which corresponds with the effects of the influence of the nervous system on it. Two other remarkable effects of this influence on the blood appear to be darkening its colour and exciting its coagulating power. It is only

* The following is the statement given by Mr. Earle:

		Before electricity.	After electricity.
Paralyzed limb ..	Hand	70	77
	Arm	80	83$\frac{1}{2}$
	Axilla	92	93
Healthy limb....	Hand	92	92
	Arm	95	95$\frac{1}{2}$
	Axilla	96	96

after the blood is exposed to the influence of that system that it assumes a dark colour in the healthy animal, and as the influence of the nervous system on the blood appears to be the means employed in the various assimilating processes, this influence must possess the power of causing the coagulation of its fibrine. These are also the immediate effects of galvanism on arterial blood, and it produces these effects more readily than any other artificial agent. It also appears from the observations which have been made, that an excessive impression communicated through the nervous system, is capable of immediately destroying the coagulating power of the blood. The same is true of the excessive application of galvanism.

It follows from all that has been said, that galvanism, applied to the different parts of the animal body while they retain their vital power, is capable of the various functions of the nervous system. We are, therefore, naturally led to inquire whether the influence of this system possesses any of the more familiar properties of galvanism. We find this question also answered in the affirmative. The influence of the nervous system is capable of its functions after having been made to leave the nerve, and pass through certain conductors of galvanism *.

It seems at first view surprising that the influence of this system should pass so readily by the ganglionic nerves after their division, since we know from every day's experience that this never happens in the spinal or cerebral nerves. But the different circumstances in which these nerves are placed, seem readily to explain the difficulty. We know that the power of secreting surfaces is increased for the time, if they retain their healthy state, by any cause which occasions a greater than usual determination of blood to them. The presence of this fluid in such surfaces, therefore, solicits towards them a corresponding supply of the influence of the nervous system. Thus there is a cause soliciting a flow of this influence to the extremities of the ganglionic nerves, which has no existence in the case of the cerebral

* *Philosophical Transactions* for the present year. Experiments related in the 23d number of the *Journal of the Royal Institution*, page 18.

and spinal nerves. There is nothing in the muscular fibres to solicit this influence. They are passive till it is applied to them.

RECAPITULATION.

It appears from all that has now been laid before the reader that there are three distinct powers in the animal system which have no direct dependence on each other, for we have seen the muscular surviving both the sensorial and nervous power, and the nervous the sensorial and muscular power; and nobody has supposed that the sensorial power has any dependence on either of the others, except as far as they are necessary for the maintenance of its organs, in which respect the nervous and muscular in the more perfect animal are equally, though not so immediately, dependent on the sensorial power.

The nervous and muscular powers are, on the one hand, the direct means of maintaining the life of the animal, and on the other, of connecting it with the external world; the former receiving impressions from that world, the latter communicating impressions to it. All the functions of both powers bear a strong analogy to the properties of the world with which they are thus associated; we therefore have reason, according to principles above stated, to believe that all these functions, as is evidently the case with many of them, are the results of inanimate agents acting on vital parts*. There is none of them, as appears from the experiments which have been referred to, which may not be excited by artificial means as long as its organs retain the vital principle; and it is a remarkable fact, that they are all capable of being excited by one agent, and that an agent universally diffused, which we know from other facts to be intimately connected with the animal economy, and which in some

* The nervous power, by which the impressions on the organs of sense are conveyed to the sensorium, receives those impressions from inanimate matter. Even the heart is excited by inanimate agents, for although the blood be alive, it is by its chemical properties and bulk that it excites the heart and vessels, as appears from rendering the blood more or less stimulating, and greater or less in quantity.

of its most characteristic properties the influence of the nervous system resembles. Lastly, we know that an agent of the same nature with that of which we now speak, electricity, is in some animals capable of being collected and applied by the organs of the nervous system.

When from the nervous and muscular we turn to the sensorial functions, we perceive results which have lost all analogy to those of inanimate matter. They have only an indirect effect in maintaining animal life, and are excited by no impressions but those communicated through the nervous system, and consequently are the results of living parts acting on each other. Hence it is, that they are the first functions which cease when the vital power begins to fail. In the nervous and muscular functions an inanimate agent excites the languid powers of life. In the sensorial functions, the functional power and the stimulus which excites it, being equally vital powers, fail together.

When the nature of the sensorial functions is kept in view, we cannot be surprised that the attempts to refer them to a more general principle have proved so futile. To what other principle shall we refer the effects of the vital parts of animals on each other, when it is in animals alone that such parts ever influence each other? Even in vegetable life we find nothing analogous to the sensorial functions. All its processes bear the same analogy to the properties of inanimate matter, which we observe in the functions of the nervous and muscular systems of animals, and are, therefore, the results of inanimate agents acting on living matter*. Much less can we look for any analogies of this kind in inanimate nature itself. Such reveries may please as the creations of the poet, but admit not of serious discussion. We are charmed with the flights of Lucretius, but we see only the perversion of philosophy in the reasonings of Hartley.

If the foregoing inferences from the various experiments

* It is here worthy of remark, that many phenomena render it probable that there is a continual passage of the electric influence through plants, to which both their form and position are peculiarly adapted.

which have been referred to be correct, it is reasonable to suppose that they may be beneficially applied to the practice of medicine. The view of the different functions of the animal body, and their mutual dependence on each other afforded by those experiments, cannot, in that case, fail to be of use in explaining the nature and regulating the treatment of the deviations of these functions from the healthy state, particularly in the diseases whose symptoms are most influenced by the mutual sympathy of the vital organs.

In a Treatise on Indigestion, I have attempted its application to an extensive class of these diseases. But I here wish chiefly to direct the reader's attention to the practical results from the experiments which relate to the influence of galvanism on the animal body.

They led me more than six years ago to the employment of this agent in diseases, which seem to arise from a defect of nervous power, particularly habitual asthma and indigestion; and an account of its effects in those diseases was published in the *Philosophical Transactions* of 1817. It is now admitted, I believe, by all who have witnessed them, that in the former disease, and under certain circumstances of the latter, galvanism is the most effectual means of relief which we possess.

In its employment, we must constantly guard against the inflammatory diathesis, both because it tends to produce this diathesis, and because the diseases to which it is adapted, for reasons pointed out at length in the Treatise on Indigestion, to which I have just referred, have the same tendency. As any considerable degree of the inflammatory diathesis not only obviates the beneficial effects of galvanism, but renders it injurious, the constant superintendence of a well-informed practitioner is necessary. I need not here enter more particularly into this part of the subject, which has been done in that treatise, and in my *Experimental Inquiry into the Laws of the Vital Functions*, in which the reader will find a detail of cases cured, or relieved by galvanism. To its effects in one case of considerable importance I shall beg leave more particularly to direct the reader's attention, because it is only since I last had occasion to

mention the subject publicly, that I have witnessed them. Mr. Earle some time ago asked me, if I thought galvanism a probable means of relief in dyspnœa and indigestion, arising from disease of the spinal marrow. I did not hesitate to recommend a cautious trial of it, referring Mr. Earle to what I had said of such cases in the last part of the above-mentioned Inquiry. I am happy to say the result has fully answered our expectations, as appears from the following letter which Mr. Earle did me the favour to address me.

" *George Street, August* 14, 1822.

" My dear Sir,

" I have much pleasure in transmitting to you the following account of the trials made with galvanism at St. Bartholomew's Hospital. The first case is that in which you witnessed its first application.

" Elizabeth Pepperall, aged 17, of fair complexion, and light hair, was admitted into St. Bartholomew's Hospital in August 1821, in consequence of an affection of the spine, which had existed for about a year and a half. At the time of her admission, it appeared, that almost all the dorsal and lumbar vertebræ were affected. She had nearly lost all power over her lower extremities and pelvic viscera; and she complained of very severe cramps at the pit of the stomach, and acute pain in the course of the costal nerves, which was much increased by pressure on the ribs, or any attempt at a deep inspiration. Her general health was much deranged; her pulse was very rapid, with occasionally severe palpitation of the heart, and constant dyspnœa. Her digestive powers were greatly impaired, she had no appetite; and could only digest a small portion of stale bread and some milk and water. Even this meal was always followed by uneasy sensations at her stomach, and an increase of head-ach, from which she was hardly ever free. Her bowels were obstinately costive, and the urine was scanty, and deposited large quantities of lithate of ammonia.

" She was placed on one of my invalid beds, which enabled her to remain in a state of uninterrupted rest; and after the

repeated application of leeches, issues were made on either side of the dorsal spine, and subsequently in the lumbar region. The issues were kept actively open, and the strictest attention was paid to her general health. The spine very gradually became less sensible, and the power over the pelvic viscera and lower extremities slowly returned; still, however, her stomach was incapable of digesting any other food than bread and milk and water, her head-ach remained nearly unabated, and her breathing was habitually difficult. She was in this state when you saw her and the galvanism was first administered (December 19.)

" A trough containing plates of about three inches was employed. The positive wire was applied to the nape of the neck, the negative a little below the pit of the stomach. No sensation was at first produced by twenty plates; but after the sensation was excited, she could not endure more than twelve. The first sensation she experienced caused her to take involuntarily a sudden and deep inspiration. The galvanism was applied for about a quarter of an hour, at the end of which time, her breathing became much freer than it had been for many months. Of this she repeatedly expressed herself perfectly certain, at the same time she felt considerable uneasiness at the stomach. She was slightly hysterical, in consequence of the agitation she had experienced, but her breathing was tranquil during the whole evening.

" With a view to remove the tenderness in the epigastrium, leeches were applied to the region of the stomach, and the whole plan of treatment adapted to the secondary stage of dyspepsia was resorted to. When the tenderness had somewhat abated, the galvanism was repeated with more decided relief to the breathing, and without causing much uneasiness at the stomach.

" After several applications of it, the relief she experienced in her breathing lasted for two or three days, and at length it was only necessary to repeat it occasionally. The effect of its administration was uniformly the same; a most sensible and speedy relief from a state of anxious breathing to perfect ease and repose. Its beneficial effects were not, however, confined

to the respiration; the powers of her stomach greatly improved, and she was able to digest a small quantity of meat or the yolk of an egg without pain. As her stomach improved, she lost the distressing head-ach, which had so constantly attended, as at one time to lead me to apprehend the existence of disease in the brain, having met with other cases in which scrofulous affection had existed in the brain and spine at the same time. Her progress from this time was uniform, and far more rapid than it had been before; and in about two months, the catamenia, which had been suspended from the commencement of the disease, returned.

"The patient was sufficiently recovered to leave the hospital, and return to her friends at Dartmouth early in July; at which time she was able to walk with very little assistance, and without experiencing the least pain in her back. On reviewing the circumstances of this case, I have not the least hesitation in stating my decided opinion of the great benefit which was derived from the employment of galvanism, not only in affording temporary relief to the breathing, but in improving the secretions, and thus materially contributing to the ultimate recovery of the patient. I feel particularly happy that the patient was in a public hospital, and that the means were employed in the presence of many intelligent medical friends and pupils, who were all equally satisfied with myself of the essential and permanent benefit which she derived from the administration of galvanism.

"It was employed in two other similar cases in the same hospital, those of Ann Baillies, and Maria May, in which it produced similar good effects, except that in one of these, the improvement of the general health, although not less than in the other cases, did not appear to have the same beneficial effect on the disease of the spine. It was tried in another case of spine disease, which was attended with fits of spasmodic asthma. These, as I was taught to expect, from the observations you have published on this subject, it failed to relieve. It is remarkable, that in the case of Ann Baillies, in which the pulse was from 140 to 150, and very weak, the use of the gal-

vanism always rendered it stronger and brought it down from thirty to forty beats in the minute.

"From observing the good effects of galvanism on the secretions of the stomach, I was induced to make a trial of it in a case of deafness, accompanied with a total want of secretion of cerumen in the right ear. Its first application produced a watery secretion, which by perseverance gradually assumed the taste and all the other characters of cerumen. The hearing was greatly improved in both ears, but how far this was to be ascribed to the restoration of the secretion is rendered doubtful, in consequence of a tumour having at the same time been removed from the tympanum of the left ear by the repeated application of caustic.

"The foregoing facts you are perfectly welcome to make any use of, should you think them deserving of notice, and I am,

My dear Sir,

Very sincerely, yours,

HENRY EARLE."

It appears from the foregoing statement, that in disease of the spinal marrow, galvanism is not only capable of performing the function of the diseased part of this organ, by which the vital actions are restored to a state of health, and the patient's sufferings greatly mitigated; but that, it also, as might *à priori* be expected, by thus improving the general health, indirectly contributes to the cure of the spinal disease. With regard to the last case mentioned by Mr. Earle, in which the secretion of cerumen was restored by galvanism, this, it is evident, from what has been said, can only happen when the fault consists in a defect of nervous influence, and not in a diseased state of the vessels.

When we compare the foregoing report of Mr. Earle with the statements which I have already had occasion to make public, respecting the effects of galvanism in other diseases, may we not hope that if in so few years such has been the result of the employment of this remedy on the principles above laid down, a more extensive experience will still extend the advantages derived from it. I have repeatedly seen its use more successful than any other means in obstinate general nervous debility,

in which transmission through the stomach and lungs has still appeared to me the best means of applying it. In certain species of fever, and other cases attended with deficient nervous energy, we have reason to believe that it will be found a valuable remedy.

I may close these observations by observing, that when galvanism is not used to such extent as to occasion an inflammatory tendency, I have never seen any bad effect from it, except a sense of languor, similar to the feeling of fatigue, when its employment has been too long continued. The inflammatory tendency produced by it, according to my experience, is always easily removed; is never followed by any serious consequence; and, with a little care, may almost always be prevented. I have repeatedly observed that when the cure has advanced to a certain point, its judicious employment, so far from causing the inflammatory tendency, has, by improving the state of the secreting surfaces, relieved that caused by the disease.

Art. IX. *Meteorological Observations in a Voyage across the Atlantic. By* H. T. Colebrooke, Esq.

During a recent voyage, in which I traversed both the Northern and Southern Atlantic twice, my attention was engaged, among other meteorological observations, to note the temperature of the sea's surface, of the atmosphere over it, and the hygrometric state of the air.

Upon the sea, as phenomena are little varied, their causes may be the more easily investigated, provided observations be sufficiently multiplied. Upon land, where changes are more frequent, and appearances more diversified, it is difficult to set aside extraneous and incidental circumstances, to fasten upon those which are effective and essential.

In the middle of the ocean, where winds are constant and the seasons regular, a continued sameness presents particular facility for such inquiries. There are fewer casual concomi-

tances to be discarded, in seeking causes, which are in perpetual activity, for effects which are unceasingly manifested. The questions are comparatively simple: but, being well determined, they may assist wider researches, where subjects of inquiry are more complex.

On this account, meteorological observations, taken in the middle Atlantic, where the *trade-winds* constantly blow, may be considered useful, as tending to ascertain, not only the reason of their constancy, but likewise mediately the cause of periodical and variable winds elsewhere.

In like manner the marked prevalence of fair weather within the limits of the *trade-winds*, and the contrasted frequency of rain in the tract which intervenes between their range, lead to remarks which may go to elucidate the theory of rain and of clouds, and lay grounds for general inferences in promotion of meteorological science.

With such views, I was desirous of using the occasion, which a voyage afforded to me, for making observations; and among the divers objects to which my attention was directed, the topic, which has chiefly engaged me, has been the hygrometric state of the atmosphere above the sea: a subject not much pre-occupied. The result is here given in a tabular form of diary; to which a few remarks will be prefixed.

The main observation for each day was taken about sun-rise, which is considered to be a favourable time, giving nearly or precisely the temperature of the night, yet unaltered. Another observation was commonly set down for noon, being taken at that time, or soon after it. Divers observations, at different hours of the day, are noted according to circumstances. They were in general frequently repeated; but, for brevity's sake, have been passed over, when no notable change nor deviation was remarked.

Equal diligence was not always applied to note the variations of the thermometer and hygrometer throughout. The subject of hygrometry was not taken up till the voyage was somewhat advanced: and I did not satisfy myself, until further progress

had been made, that the method, which I then had fallen upon, was sufficiently exact. Some time elapsed in trials of it, before such confidence was put in it, as led to register the observations which were made.

This very simple method of measuring humidity of the tmosphere, consists in wetting the bulb of the thermometer with water, and exposing it wet to the free access of air. The evaporation of moisture from the wet surface of the instrument reduces the temperature of it to the point at which deposition of dew takes place; provided no extraneous substance be contiguous, from which heat might be derived to the evaporating moisture. On this account the thermometer employed must not have an attached scale in contact with the bulb. It is best graduated upon the glass of the tube.

Reduction of temperature by evaporation of moisture is obviously a measure of the hygrometric state of the atmosphere: for, if the air be saturated with humidity, it produces no evaporation: if, on the contrary, it be dry, the cooling effect of the consequent evaporation is sensible; and the drier the air is, the greater the coolness which is induced: the degree of refrigeration indicates the degree of dryness.

Even upon a cursory view, coolness induced by evaporation, being noted with precision, is seen to be a hygrometric measure. It not only is so, but it is an accurate one; since it exactly designates the point of deposition of dew: whence (the atmospheric temperature being at the same time known) the quantity and force of vapour present are inferable. For evaporation of moisture from the surface of an isolated body continues to depress its temperature, until it is cooled down to the verge of the point at which dew may be deposited. It is no further cooled, since condensation would else actually take effect, countervailing evaporation, and restoring at the instant the precise quantity of heat momentarily parted with. The cooling process does not stop before it reaches that limit, unless indeed moisture be deficient, and a portion of dry surface be exposed: in which case, as in that of contact of an extraneous

body, the depression of temperature is checked, and falls short of the point of dew.

Accordingly it is found, that a thermometer, dripping wet, or wrapped in wet rag, or (bibulous) paper, exhibits depressed temperature, which continues to descend, until it arrives at a certain point, where it becomes stationary, and remains so for a while, until the surface of the instrument begins to dry, when the temperature slowly rises to that of the air around it.

The limit of depression is, as before noticed, the point of dew, or that at which condensation of vapour takes place. The difference between this and the temperature of the atmosphere, shews the degree of dryness; which is readily and conveniently observed by placing a separate dry thermometer near the wet one in the same exposure.

The exposition must be such as allows full access to the air, which is the subject of observation; in short, a free ventilation: and, provided that is the case, a difference in the strength of the current of air is attended with no variation of result; other circumstances remaining unchanged. The blast of a bellows produces no alteration; nor does a gust or puff of wind, unless the temperature of the air, or its dampness, vary.

With that simple hygrometer, observations were taken during my voyage over the Atlantic, in the latter part of the outward voyage and the whole of the returning one.

This application of the thermometer to a hygroscopic purpose was first devised by Professor Leslie; but I had not a distinct recollection of his invention, when I put a thermometer to this use; and I have therefore retained my own exposition of the grounds on which I then proceeded; and the rather, as differing in some respects from his*.

It is an instrument of much readier application than Mr. Daniell's hygrometer; and, as I apprehend, accurate, and sus-

* Since this was written, I learn, from an Essay by Mr. Ivory, that the invention belongs to Dr. James Hutton.

ceptible of being rendered one of great delicacy in a very simple form.

As degrees of dryness, referred to the varying temperature of the atmosphere, want a common measure for purposes of comparison; to obtain one, I deduce from the observed temperatures of air and vapour, the actual capacity of the atmosphere for moisture and the quantity present: the expression of the ratio of that capacity to the difference, gives the dryness or relative quantity deficient to saturation. It is expressed in centesimals. Its complement is the proportion of moisture present at the time of observation.

The same purpose would be answered by computing the elastic force of vapour from the temperature and degree of dryness.

In employing a thermometer for its usual and direct purpose, precaution is requisite to avoid error in observations taken on ship-board; for it is the temperature of the sea or of the atmosphere, not that of the ship, which is to be ascertained. It was my practice to expose the thermometer over the windward side of the vessel, or to suspend it out of the cabin-port or stern-window, in the shade, and in a situation to have free access of air, unaffected by radiation or reflection from any thing appertaining to the ship.

In using the thermometer for hygrometry, similar care was employed to present the instrument to the free access of air from the sea, independent of the influence of a wet deck, or any other presumable source of error. Many of my earlier observations have been rejected, as, for want of some precautions, they are liable to suspicion of error.

To try the temperature of the sea's surface, a thermometer was sometimes let down to it. More frequently sea-water, fresh drawn, was examined.

In general the temperature of the sea's surface differs little from that of the air immediately over it; or the small difference, which is perceivable at one time of the day, is reduced at another; when the degree of heat exhibited becomes nearly

uniform in sea and air. Much discordance does not ordinarily occur, unattended by change of wind.

The most striking instances, which fell under my notice, were in the southern hemisphere*. Within the same parallel of latitude (32° 40′ to 33° 40′) the temperature of the air, which had suddenly fallen not less than 5° on passing from a north-west gale to a south-west breeze, and which as quickly rose just so many, on reverting next day from this to a strong north-westerly breeze, sunk twice as much (10°) upon a violent shift of wind to south-west, and thence to south-east and east. The alteration of temperature of the sea, though not quite keeping pace with that of the atmosphere, was considerable, amounting to 4° and 5°. The variance of temperature of sea and air was consequently conspicuous; it was so much as 6° one day.

In the northern hemisphere, I had occasion to remark a sudden fall of temperature of both sea and air, attending a change from a south-western breeze to a northern gale.

In a different instance the temperature of the air was affected by a shift of wind, with no correspondent change in the sea.

Both are common cases; but I refer to instances in which the contrast was striking.

Such discordant variations of heat in the sea's surface and superincumbent atmosphere, mark a shift of wind. Concurrent changes of temperature of both indicate transition from a tract in which one wind was prevalent, to another where a different one prevails. In the first case, the wind has veered; in the second, the ship has passed from one wind's range into that of another.

The temperature both of the sea and of the atmosphere usually varies not much in the course of the day; and that of the sea least. The diurnal variation of the air, unless in extraordinary instances of sudden transition, did not exceed 4°.

* 4th and 5th Dec.

It sometimes amounted to 2° or 3°; and not unfrequently was null; and was so for air both in shade and sunshine.

The diurnal changes of temperature of the sea were less diligently watched. In ordinary instances, so far as observed, the fluctuation scarcely exceeded 2°, and was often null.

In a brisk current of air, such as usually prevails on the open sea, the temperature of an object, exposed to sunshine and wind, is very little raised by the sun's direct influence; because the quick passage of a current of air diffuses an equable heat, taking away and scattering particular superabundant warmth. On ship-board, therefore, in a fresh breeze, the temperature is nearly or precisely the same in the shade and in ventilated sunshine, even at noon; excepting of course such surfaces as from colour or texture are peculiarly fitted to absorb heat; and excepting likewise objects skreened from the wind and exposed to reflected heat.

The remark has been very frequently verified in course of the voyage; and the same observation may be made on shore, if care be taken to exclude the influence of reflected heat, and to admit free ventilation.

But, in calms and light breezes, a sensible difference of temperature (from 1° to 4°) occurs in sunshine and in shade, however open the exposure may be. That difference is attributable to the direct effect of the sun's rays on the instrument with which the observation is taken.

The sea in few instances was at the point of dew; in fewer, below it. The weather was in such case hazy; or mist attended the deposition of dew, which of course was then going on at the surface of the water.

Amidst fogs and mists, this is frequent; but such is not the climate of the middle Atlantic; and the temperature of the sea's surface rarely descends to that point during either the night or the day.

On ship-board, dew is not uncommon; especially in clear nights, upon black surfaces and other cooling substances. But the sea does not so readily arrive at the same reduced tempera-

ture. Its agitation, and wind passing over it, tend to maintain a more nearly uniform heat.

The point, at which deposition of dew takes place, is more stable than that of the temperature of air. It fluctuates scarcely more than a degree in course of the day, unless upon occasion of a sudden or violent change of weather. Very few such instances occurred to notice: and variations in degrees of dryness are more owing to diurnal alterations of temperature in the atmosphere, than to changes of that at which vapour becomes condensable. Evidence of this fact recurs at every turn.

The utmost degree of dryness observed in the atmosphere over the sea, either with a *trade-wind*, or with a north breeze in the northern Atlantic, or a south wind in the southern, has been nearly one-third of the air's capacity for moisture: (.30 to .31 centisimals.) The maximum on shore, in South Africa, as actually observed upon the sea-coast, has been twice as much. A greater degree of dryness was experienced at inland stations; but instruments were not at hand to determine its precise quantity.

The minimum was of course, both on sea and on land, the point of saturation with moisture, or zero of dryness: which, however, rarely occurred; and only in mists or continued rain, or stormy and wet weather.

The temperature of the mid ocean is lower than that of seas nearer to land. In this respect, the influence of the continent of Africa, appears to extend as far as to the clusters of islands which lie at considerable distance off its shores; or those islands have themselves a sensible influence over the seas around them.

A month after the autumnal equinox, the sea and atmosphere over it, in the vicinity of the Madeira islands, exhibited a mean of 73°; *viz.*, air, 72°; water, 74° to 73½°. But, near the summer solstice, in the same parallel of latitude, at a distance of more than three hundred leagues west, the temperature was 69°; *viz.*, air, 67° to 69°; water, 69° to 70°.

Near the Canary islands, and Palma island in particular, at

the end of October, the temperature was 74° (atm. 74°; rising to 76° at noon; sea, 73°.) In the same parallel, at a distance of three hundred and fifty leagues west, in the beginning of June it was 72°; (sea and air, 71° to 73°.)

Near the Cape de Verd Islands, and close to S. Antonio, Brava and Fuego, early in November, the temperature was 79° (sea and atmosphere 78° to 80°.) In the like parallel, at a distance of a hundred and fifty leagues west, not more than a month before the summer solstice, it was 75°; (sea and atm. 74° to 76°.)

In like manner, the temperature, a hundred leagues from the coast of Europe, was 67° in the middle of October; and among the Azore islands, at the distance of two hundred leagues further west, it was 66° in June.

The southern *trade-wind* being cooler in like latitudes than the northern, usually passes the equinoctial into the northern hemisphere. The northern *trade-wind* falls considerably short of it, as earlier attaining the maximum of heat.

Between them is a region of variable winds, light airs and calms, attended with frequent squalls and rain: an uncertain, wavy zone, lying between the terms of their influence. It is the tract, in which the highest temperature prevails through the year, not at the equinoxes only, the sun being then vertical; but also when he is distant at the tropics.

The mean temperature of the sea and atmosphere does not there exceed 82°; for such it was found in May and November, seasons almost equally distant from solstice and equinox. It scarcely rises to 84° at noon in the shade; and barely descends to 80°, at the coolest moment of night or morning.

Here the influence of the ocean in mitigating the heat is apparent; for, in a like parallel of latitude on land, the mean temperature is reckoned to be 84°.

In this warm and damp region of the middle Atlantic, situated in the vicinity of the equator, the point of deposition of dew appears to be about 78°. The dryness is ordinarily below a tenth part of the air's capacity for moisture; and often de-

scends to a less proportion; but sometimes at noon (the weather being fair) rises to a sixth, and even a fifth part.

Besides the equatorial zone, or tract intervening between the *trade-winds* in the vicinity of the equator, where a nearly equable temperature and uniform humidity prevail, other belts of both equable temperature and humidity are indicated; for transitions are not always regular, even within the limits of unvaried winds.

Some less distinctly marked, may for the present be passed by; but, on the exterior side of either tropic, for a breadth of five or six degrees of latitude towards the further bounds of the *trade-winds* (lat. 28° or 30° N. and S.), there seems to be such a zone strongly pronounced. In the southern one, the mean temperature of the sea was 73° in November, (beginning of summer); and $69\frac{1}{2}$° in April (autumn): the point of dew at the latter period was almost as uniformly $63\frac{1}{2}$°: the temperature of the air scarcely deviated more than a degree from a mean somewhat above that of the sea in the first season, and a little below it in the second.

In the correspondent northern zone, the mean temperature of the sea was nearly 74° in October, and 72° in May, a little below that of the air in the first mentioned season, and above it in the last. The point of deposition of dew was about $67\frac{1}{2}$° in the latter season, fluctuating 1° on either side of that mean.

At the position, where observations taken by me at different seasons, admit of direct comparison; that is, where the two routes intersect; which was about lat. 3° N. and long. 22° W.; the temperature was found, in the middle of November, (with a south-east *trade-wind*), of the sea, 79°; of the atmosphere, $80\frac{1}{2}$°; increasing to $82\frac{1}{2}$° at noon; and it was in the middle of May, (with variable winds and calms,) of the sea, 83°; of the atmosphere, 80°; rising to 83° at noon.

Here the contrast is between the temperature of the sea at two seasons; that of the air being nearly the same at both. The sun was at both times increasing his distance towards a solstice. The effect then upon the heat of the sea's surface is to be ascribed to the cooling power of a dry wind in one case,

and to the want of that refreshing influence in the other; in short, to the *trade-wind*, which probably lowers the temperature of the sea's surface, by evaporation; for it is dry, while equatorial winds are damp.

The *trade-winds*, which blow over the middle Atlantic, are ascribed to the rarefaction of the atmosphere by the sun's heat. Their proximate cause seems to be the diminution of the air's specific gravity by absorption of moisture. No doubt they are a supply of denser air taking the place of that which is lighter, and which rises therefore in the atmosphere.

Diffusion of moisture, like that of temperature, through air, is attended with internal commotion. Particles of air, becoming lighter by accession of warmth or of moisture, from a warm or a humid surface, rise and are succeeded by others; which in their turn become light, and similarly ascend. This has been long since shewn in respect of diffusion of temperature in fluids; and may be presumed in regard to humidity, as a more consistent explanation than that which supposes moisture derived by affinity of a less saturated portion of air above, from a more saturated one beneath; and so enabling this to dissolve more, which is in like manner transmitted.

While evaporation is going on, humid air is continually rising. It quits the evaporating surface, previous to full saturation, because it earlier becomes specifically lighter than drier air immediately above it; and rises therefore through superior strata, until it reaches an elevation suited to its levity: and there gradually parting with excess of heat, parts likewise with moisture which it can no longer sustain. At that elevation, therefore, vapour is condensed from it; and clouds are seen.

The atmosphere over the sea, examined as close to the surface as waves permit, manifests no saturation, though sensibly moister than at a little height above it. For instance, a difference of one degree of dryness has been observed at an interval of eleven feet, when the temperature at both places has been 67°, and the point of dew was 59° at the upper station, and 60° at

the lower, close to the sea's surface. The weather was at this time nearly calm, and the atmosphere unusually dry.

Confined air, environed by moisture, becomes fully saturated with it. Not so, unconfined air, even upon the face of the sea. Were the atmosphere over the high seas, or the inferior strata of it constantly saturated, or nearly so with humidity, a fog or mist would be perpetually hanging upon the face of the ocean, or low clouds be suspended over it. A serene sky, or a clear sea, would scarcely occur. The air is generally damper on sea than on land; but not approaching to saturation.

According to the observations made by me, the degree of dryness within the limits of the *trade-winds*, was ordinarily about 4° or 5°, implying nearly a sixth part wanting to saturation. It seldom descended below 3°; but often rose to 6° and 7°, and sometimes to 8° and even to 9°; which extreme point implies, at the temperature attending it, nearly a third part wanting to saturation.

The mean dryness in the range of the *trade-winds*, may be taken at 4° to 5°, attended by temperature from 68° at the furthest limit of their influence, to 82° at their nearer confines.

Between the lower strata of the atmosphere which may be hygroscopically examined, and its upper strata, the hygrometric condition of which is but to be conjectured from the appearances put on by clouds in them, continued interchange is going on, by reason of evaporation, as well as in consequence of unequal temperature. Warm humid air ascends; cool or dry air succeeds to it.

Whether it be heat or humidity, or both, by which air is rendered specifically lighter, it must from its levity, rise in the atmosphere and give place to other, which is heavier. Dry air rushes to replace moister, in like manner as cold air does so to take the place of warmer; that is, in both cases, denser instead of that which is less so. The one, which comes in place of the other, may be both drier and colder than that to which it succeeds, or it may be heavier only by the difference of the excess of one quality above the defect of the other. It may be drier and

warmer, or it may be colder and damper; provided the excess of dryness in one case, and that of coldness in the second, surpass the superabundance of warmth and of moisture respectively.

Wind, passing from a frozen region to a more temperate one, is an instance of a current of cold and dry air.

A parched hot wind, such as blows off a heated desert, is an example of an atmospheric current, wherein excess of dryness overpowers deficiency of cold.

Cold damp winds, such as blow from the sea upon the shore, exemplify currents of air, in which excess of cold outdoes deficiency of dryness.

Land and sea breezes, alternating upon coasts in warm climates, are likewise instances of dry but hot wind, and cool but damp. When excess of dryness above warmth in the atmosphere over the land, surpasses that of cold above moisture in the air over the sea, a land-breeze blows: when excess of cold above humidity upon the sea outgoes that of dryness above heat on shore, the sea breeze sets in.

Warm and damp air, being lighter than that which is either cool or dry, can be but an ascending current, and may be felt as wind upon an acclivity or elevation. A descending current of air, as well as an ascending one, is ordinarily referred by the feelings to a horizontal direction. The impulse of the wind is, in either case, oblique: but, in the sensation of it, a moderate degree of slope is not distinctly perceptible. An ascending current then may be wind, in like manner as a descending one certainly often is so. A puff of air from a passing cloud, and a gust from a neighbouring mountain, are, no doubt, descending currents, though their slanting direction may be unobserved. A puff of warm air is not unfrequently felt on the side of a hill, unquestionably coming from the valley below; and a fog is very commonly seen rising from the sea towards a high coast.

A *trade-wind*, passing from a cool and dry, towards a warm and damp, region, may comprise descending currents of air, which feed its continued progress. At its outset, it seems to be indubitably such. Thus, in the northern Atlantic, from the

same limits, whence the north-east *trade* blows towards the equator, a south-west (or rather west-south-west) wind, not uncommonly prevails in the contrary direction. So, in the southern Atlantic, from the limits of the south-east *trade*, the prevalent winds are nearly converse, (west-north-west.) Now, adverting to these winds blowing contrariwise from the same limit, there is difficulty to conceive the origin of either *trade*, but as derived from upper strata of the atmosphere: and, if that source of supply at the commencement be acknowledged, there is little reason for rejecting it in the wind's subsequent progress.

In the *trade-wind* humidity is gently rising; and cool air descends in a slanting direction towards a warmer region: the vicinity of the equator.

In the *averse* wind, vapour in solution ascends, with warm air, which passes towards a colder and more elevated region.

Both are undulating currents: but, in one, dry air descending is characteristic; as, in the other, moist air ascending.

The western winds that prevail beyond the range of the easterly *trade-winds*, not blowing with the same constancy, present not an equal opportunity for a followed series of observations of them within a brief compass. It is apparent, however, that the western winds are, in general, more charged with humidity than the eastern; and winds, receding from the equator and tropics, more so than those which are pointed towards the equator.

Rising currents of damp air do certainly occur: not merely presumed or surmised; but clearly presented to notice, and made manifest by clouds drifted with them.

Upon numerous occasions, when the wind has been in a different quarter, the unconformable course of clouds has distinctly shown a superior current loaded with humidity. Several times, in both hemispheres, I have particularly remarked clouds moving across the wind, drifted evidently by an upper current; for example, from west to east over a south-east breeze, in the northern hemisphere; and from north to south above an easterly wind in the southern.

To dwell upon the particulars of one instance here alluded

to:—About 50 leagues west of the Azore islands, with a south-east breeze, dry air and clear zenith, a fog-bank rose in the fore-noon from the whole western horizon, and spreading into an expanse of clouds continued to advance across the wind (W. to E.) until the sky became entirely overcast, and remained so during the rest of the day, with no change in the hygrometric state of the air, until a shift of wind to S. and S.W. took place in the evening. Then, and not earlier, the hygrometer varied from 5° (.20) of dryness to 4° and 3°; and next morning, the south-west breeze yet continuing, the air appeared nearly saturated with moisture, for the hygrometer showed but half a degree, (or 2 centesimals) of dryness. After two days, the south-west wind gave place to a cold northern gale, which partook its humidity; and like it was nearly saturated with moisture; but gradually recovered dryness of air under a very cloudy sky, and notwithstanding frequent squalls.

This and similar instances, afford countenance to the notion, that there are ascending currents of damp air, which at one time sweep the surface of the sea, and at another, rise into upper currents of air, giving place to wind from a different quarter beneath.

Hence they are uncertain and changeable. Not unfrequently they veer to an eastern point; and still oftener, the western winds take a southerly inclination in the southern hemisphere, and northerly in the northern: or are succeeded by winds from those quarters, bleak and dry.

It has been not altogether without surprise, that I have found usually considerable dryness of the atmosphere amidst rain. In making an observation during a shower, precaution is necessary to guard against illusion: if the hygrometer be exposed to the wet, it of course exhibits the temperature of the dropping rain itself, whatever be that of the air; if screened from wet, care is requisite to ensure free access of air to the instrument. Attending to these points, I still have found 1° or almost 2° of dryness (3 to 5 centesimals) in the atmosphere, while rain has showered through it.

Small rain, such as that which accompanies squalls not un-

frequent in the *trade-winds*, and still more common beyond their limits, appears to influence but slightly either the thermometer or hygrometer. It is a passing mist, or showery scud; or a low *drift-cloud*, sweeping the surface of the sea. A transient puff of wind attends it; and it is often succeeded by a short lull. But the humidity and temperature of the air undergo slight variation during its brief passage, and exhibit no considerable change after its transition; though doubtless the atmosphere is in both respects, materially affected by the frequent recurrence of showery squalls.

Mists, (not dry fogs, but wet or moistening), have a manifest influence on the hygrometer. In this case, saturation, or all but saturation, is exhibited. They are in fact the consequence of extreme humidity.

A heavy shower draws down air with it. Both the rain, and the air attendant on it, bring with them the temperature of the higher atmospheric strata, from which they descend. In the tract of variable winds, situated between the *trades*, rain is heavy; and it is there not unusually accompanied by decrease of temperature, amounting to 4° or 5°: a difference of 6° and even 6½° has been observed. Hygroscopic indications at the same time are those of increased moisture; from 4° or 5° (.12 or .15) of dryness, before a shower, to 1° or 2° (.3 or .6) after it.

A passing shower, especially a heavy one, is preceded by a gust of cold air; and not unfrequently succeeded for a while by one, in the contrary direction: because the rain drags along with it air from an upper and cooler stratum of the atmosphere; and that air diffuses itself on all sides of the rainy column.

Long continued rain is comparatively unfrequent on the open ocean. Its effect, where it does occur, is no doubt to saturate the lower atmosphere with moisture; and such appears to have been the result in the few instances which came under notice.

Low clouds, whether scud or mist, participate the hygrometric condition of the inferior atmosphere; and the clouds hang low, in proportion as the air approaches to saturation of moisture. They touch the sea's surface if it be complete. Their course agrees with that of the wind.

Over them, other beds of clouds are very usually seen, passing in directions different from that of the wind.

Above all, is a stratum of clouds at rest.

Over the sea, these distinct strata of clouds are in general to be seen; or, when the layers are more numerous, they seem to be reducible to those three primary distinctions. Heaps of dense, woolly or cottony vapour, at various elevations, are driven by upper currents of air, not uncommonly deviating from the direction of the wind, which is the lowest current. Fleecy scud passes beneath, with the wind; or sometimes not quite conformably; and often scattered at more than one level, exhibiting variety of density: scud lowest; closer fleeces above that; and looser over them; marking the difference of their height by the unequal velocity with which they pass. Fibrous clouds hang over all, and remain at rest; manifesting intestine commotion, indeed, but no progressive movement.

In dry and fair weather, a serene sky presents none, but of this last mentioned character: *cirrhi*, or *cirrhostratus* of Mr. Howard's nomenclature.

They appear in this case to correspond with the observed hygrometric state of the accessible atmosphere; its dryness seems to account satisfactorily for their elevation. Vapour descending lower than the limit which that prescribes is dissolved, and becomes transparent; it ceases to be cloud.

Their source probably is warm humid air, still higher. Vapour, thence condensed upon the surface of contact, descends until it is re-dissolved. The intermediate space is occupied by cloud; seemingly at rest.

Dilute and fibrous clouds are seen at great elevation, when the air marks much dryness.

Diffused splashes, and pencilled streaks, compact but shallow, belong to less height, and less atmospheric dryness; but equally stationary, they appear to have a like origin.

Oftener, even in fair weather, attended however with a mean degree of humidity, dispersed heaps of dense vapour *(cumuli)* are seen drifted in the middle atmosphere, at a height apparently not unsuited to the observed degree of dryness. Vapour,

risen or rising, may be expected to be condensed and made visible at an elevation, where the appropriate temperature, consonant to the height, is so much less than below, as is the amount of dryness. In mountainous countries, accordingly, the altitude, at which clouds are perceived enveloping summits or sides of mountains, may serve for a hygrometric measure, and is no bad one.

With *drift-clouds*, such as have been mentioned, both scud beneath and quiescent clouds above, are not uncommonly wanting; or these are present, and scud only is deficient.

In cloudy weather, when the upper sky is at any time discovered through breaks of the extended *stratus*, a bed of diffused fibrous clouds (*cirrhi*) shews itself. The intermediate series of denser clouds is at times wanting between that bed of light stationary louds and the low fleeting scud.

At other times, and in boisterous weather in particular, stationary clouds are perceived, seemingly at little elevation above the *drifted* clouds; suddenly they appear, increase for a while, and then wane and vanish without change of place. They are produced by a stream of damp air traversing a patch of cold however derived.

An overcast sky occurs sometimes without distinct drifted clouds. The extended sheet, in this case, which is of not rare occurrence, belongs to upper passing air; the vapour of a superior damp stratum is condensed at the surface of contact with an inferior colder stratum over which it passes; and the observable dryness of which satisfactorily accounts for the elevation of the sheet of cloud above it.

Drift clouds, that disperse rain, especially the scanty spurts of it attendant upon squalls, are derived from an upper stratum of moist air. They here and there sweep the sea's surface, traversing a lower atmosphere, the hygrometric indications of which are apparently not quite consistent with their presence in it. Observations are continually showing several degrees of dryness, while showery squalls recur frequently, and are even actually passing.

In general descending *drift-clouds* hang lower than ascending

ones. Condensed vapour, sinking through an atmosphere capable of dissolving it, will yet fall partially below the precise level at which the hygrometer denotes it to be soluble: some portion, be it little or much, escapes solution, and comes down as rain. So vapour, rising into an atmospheric stratum capable of condensing it, is not all instantaneously condensed; a portion of it, little or much, passes. For both rising and falling vapour obeys the impulse of levity and weight more promptly than it relinquishes or acquires heat.

Relative height of *drifting* clouds, which has been spoken of, is to be inferred from the velocity with which they drift, as already mentioned: or that of any clouds is to be judged of according to the distinctness with which the commotion of their vapour is perceivable. For every cloud consists of transient materials; and, though seemingly a definite mass, viewed distantly and cursorily, it is, in truth, continually varied, momentarily receiving accessions on one part, and wasting on another; as is manifest when it is steadily contemplated.

The absolute height of a cloud above the sea, is in like manner to be estimated from the clearness with which the intestine commotion of its vapour is distinguishable, assisted by a habit of observation acquired amidst mountains of known altitude. Indeed, most of the phenomena of clouds require to be studied among mountains; being best explained by reference to appearances presented where they are most accessible. I shall, therefore, not enlarge on the subject of them as seen from a position whence they are least attainable.

METEOROLOGICAL DIARY.

Date	Latitude	Longitude	Temp. Sea	Temp. Atm.	Depn. of Dew	Dry-ness	Winds	Weather and Remarks
182[illegible]	° ′	° ′	°		°	°		
Dec. 1	30 18 S	21 50 W	70½	73	73	0	NNW to NW a m	Strong breeze, m. calm, cloudy, a m rain, p m rain
				2 p m 73				
2	31 36 S	19 5 W	71	73½	73½	0	NW b N to — b W	Increasing gale, clouds, rain
				m 72¼				
				7 p m 71				
3	32 15 S.	16 50 W	68	71	..	..	NW to S	Gale, rain, p m fair
				7 p m 71				
				10 p m 69½				
4	32 50 S	14 40 W	65	66	..	..	S to SW a m & NE p m	Light breeze to calm, clear to cloudy, 5 p m rain
				m 72				
				— sun 73				
				6 p m 69½				
5	33 30 S	12 48 W	70	70½	..		E to N 4 a m & NW 10 a m	Moderate to strong breeze, squalls, a m to 4 p m
				6 p m 69			WNW & SW p m	rain, and 8 p m, 4 to 8 p m fair
6	33 27 S	10 6 W	66	60	55	5	S to SE & SSE	Brisk breeze, fair
			m 64	m 61	54	7		
				— sun 64	55	6		
				6 p m 61				
7	33 42 S	9 45 W	64	61½	54	7½	E to E b S	Moderate to strong breeze, fair, p m and n rain
			3 p m 66	m 63½	57	6½		
				2 p m 62¼	56	6		
8	35 55 S	6 40 W	62¼	63½	63½	0	E b S to ENE m	Strong breeze, a m mist and rain, m & p m cloudy
			5 p m 64	2 p m 67½	65	2½	& NW & WNW	
				5 p m 67½	65	2½		

9	35 46 S	4 33 W	61¾	62¼	60	2¼	WNW to WSW	Moderate, cloudy, mist, alternating
				m 65				
				7 p m 63				
10	35 44 S	2 17 W	60¼	59¾	57	2¾	SW b W to WSW m	Moderate to brisk, cloudy, p m clear, a m mist and rain, m fair
			m 64	10 a m 60	56	4		
				m 60				
				— sun 64				
				6 p m 63				
11	35 43 S	0 11 E	61½	61¾	59½	2¼	WSW to SW 8 a m	Brisk to gentle breeze, clear
			7 p m 64	m 63	60	3		
				— sun 64	58	5		
				7 p m 63				
12	35 38 S	9 32 E	63½	62½	60	2½	WNW	Moderate, fair
			m 64½	m sun 66	62	4		
13	35 46 S	5 26 E	64¼	63¾	61¾	2	W to NW & SSW	Brisk to strong breeze, clouds, p m squalls, 9 p m rain
			10 am 65	m 66	63	3		
				— sun 67				
				7 p m 64¾				
14	35 29 S	9 16 E	61	61	57	4	SSW	Brisk to moderate breeze, cloudy to fair
			3 p m 65½	m 64				
				3 p m 67½	62	5½		
15	35 30 S	11 38 E	64¼	62¾	50½	6¼	WNW	Brisk breeze, fair
				10 a m 64	58	6		
				m 67	60¾	6¼		
				3 p m 66½				
				— sun 67				
16	35 S	14 22 E	63¾	63¾	62	1¾	NNW	Moderate, clear
			9 a m 66	9 a m 65¾	63	2¾		
				m sun 69	64	5		
				6 p m 66¼	63	3¼		
17	34 ? S	16 ½ ? E	65½	64½	61	3½	N	Moderate to brisk breeze, fair
				1 p m 67½	63½	4		
				5½ p m 67	63	4		
18	33 56 S	18 28		67	63	4	NNW	Moderate, fair

Table Bay, Cape of Good Hope.

DIARY.

Date	Latitude	Longitude	Temp. Sea	Temp. Air	Dew	Dryness Fahr.	Dryness Cent.	Winds	Weather and Remarks.
1822	° ′	° ′	°	°	°	°			
Ap. 17	33 56 S	18 28 E	....	....	...	..	...	Calm	Clear
18	33 48 S	18 25 E	....	63½	59½	6	·23	SE to calm	Clear, cloud on Table Mountain
19	33 37 S	18 2 E	60½	63½	59½	6	·23		Calm to light airs. T. M. dist. 30′, p m a shallow mist
				m 66½	63½	3	·12		
20	33 25 S	17 3 E	57½	61½	58¾	3	·12		Calm to light airs, fog
				m 59½	59½	0	·0	p m SW	Moderate, n. lightning NW
21	32 50 S	16 3 E	....	67½	64½	3	·12	a m NW	Calm to moderate, clouds
				m 67	64	3	·12		p m brisk breeze, n. squalls
22	32 40 S	14 35 E	....	64½	60½	4	·16	NW	Brisk to fresh breeze, scattered clouds
23	31 13 S	13 42 E	....	66	61	5	·20	S	Brisk breeze, scattered clouds
24	30 1 S	11 43 E	67½	65½	61½	4	·16	S to SE	Moderate, fair
25	28 20 S	9 20 E	69½	67½	63½	4	·15	SE	Brisk, a m clear, m cloudy, p m overcast sky
				p m 68½	64½	4	·15		
26	26 31 S	6 45 E	69½	66½	63½	3	·12	S to SE	Brisk to fresh breeze, overcast sky
				m 68½	63½	5	·18		
27	24 31 S	4 6 E	69½	68	63½	4½	·17	SE	Fresh breeze, overcast sky
				8 a m 68½	61½	7	·25		
				m 69½	60½	9	·31		
28	22 31 S	1 32 E	69½	67½	63½	4	·15	SE to SSE	Fresh breeze, fair, scattered scud
				p m 68½	63½	5	·18		
29	20 40 S	1 11 W	69½	68½	64½	4	·15	SE	Fresh breeze, clouds in triple series, squalls, 2 p m small rain
				9 a m 69½	65½	4	·14		
				2 p m —	67½	2	·07		
30	18 38 S	3 24 W	72	71	66½	4½	·15	SE	Fresh breeze, fair, squalls passing
May 1	16 28 S	5 39 W	72½	73½	67½	6	·19	SE	Fresh breeze, fair, squalls passing
				p m 73	68	5	·16		St. Helena I. m. dist. 30′ and 3 p m dist. 17′
2	14 33 S	7 50 W	74	74	68½	5½	·17	SE	Fresh breeze, clouds in triple series m clear
			m 74½	m 75½	67½	8	·23		
				p m 74½	69	5½	·17		
3	12 39 S	10 2 W	75½	75	69½	5½	·17	SE	Brisk, fair, 4 p m rain
				m 77½	70½	7	·19		

4	11 4 S	11 43 W		76½		76½	71½	5	.14	SE	Moderate, clouds in triple series
					p m	77½	72	5½	.15		
5	9 25 S	13 10 W		77½		78½	74	4½	.12	SE	Moderate, fair
					m	79½	73	6½	.17		
6	8 7 S	14 36 W		78½		78½	73½	5	.13	SE	Moderate, fair, scattered clouds, Ascension I. dist. 18′ at m
						79½	73½	4	.11		
7	6 38 S	16 3 W		80½		80½	76½	4	.10	ESE to SSE	Moderate breeze, scattered clouds, p m squalls, mist and rain
			m	81½	m	82½	77½	5	.14		
					p m	80	77½	3	.03		
8	5 1 S	17 56 W		81		81½	77½	4	.11	ESE	Moderate, fair, p m cloudy
			m	82	m	82½	77½	5	.14		
9	2 52 S	19 11 W		79½		81½	77½	4	.11	SSE	Moderate, hazy, m and p m squalls, p m and n showers of rain
					m	79½	78½	1	.03		
			p m	81½	p m	82½	78½	4	.11		
10	1 S	20 5 W		82		82	78	4	.11	ESE to variable	Moderate, clouds lowering, a m and p m rain
					p p	79½	77	2½	.07		
11	0 48 S	20 20 W		81		80	78	2	.05		Calm, clouds, squalls, rain
					m	82½	78	4½	.13		
			p m	79½	p p	76½	74½	2	.06		
12	0 40 N	21 12 W		81		81½	77½	4	.11	E to ESE	Light airs to moderate breeze, cloudy, squalls passing
			m	80½	m	83	76½	6½	.20		
					p m	83	77	6	.18		
13	2 34 N	21 57 W		82½		80½	76½	4	.10	S to SSE	Moderate, cloudy and hazy, squalls, a m and p m rain
					m	81½	77½	4	.11		
			p m	84½	p m	80½	78	2½	.07		
14	3 40 N	22 16 W		83½		79½	77	2¾	.07	NE	Light airs, clouds, squalls, p m and m rain
					m	83½	79	4½	.13		
			p m	82	p p	80½	78½	2	.05		
15	4 40 N	22 16 W		81½		80	78	2	.05	NE to variable	Moderate, clouds in triple series, squalls passing, m rain
					m(?p)	83½	78½	5	.16		
					p p	79½	77½	1¾	.04		
16	5 5 N	22 41 W		81½		79½	79½	3	.08	NE to variable e p m SW	Light airs to moderate breeze, passing squalls, n and p m rain
			m	83½	m	84	79	5	.16		
			p m	80½	p p	77½	75½	2	.06		
17	5 47 N	23 25 W		81½		76½	75½	3¾	.19	NNE to N and variable	Light breeze, cloudy, squalls, a m rain
			p m	80½	p p	77½	75½	2	.06		
					—	77½	76½	1	.03		
					p m	78½	77½	1	.03		

DIARY,—CONTINUED.

Date	Latitude	Longitude	Temp. Sea	Temp. Air	Dew	Dryness Fahr.	Dryness Cent.	Winds	Weather and Remarks
1822 May 18	6° 18′ N	24° 6′ W	81°	79½°	70½°	2¾°	.07	NE	Moderate to light airs, cloudy to fair, m rain
			m 79½	p m 81	70	5	.14		
19	7 1 N	25 25 W	81½	79½	73½	4	.11	NNE	Moderate, scattered clouds in triple series
				m 81½	—	6	.15		
				p m 81	76½	5	.13		
					—	4½	.12		
20	7 59 N	26 56 W	79½	78½	73½	5	.13	NNE	Moderate, fair to clear
				m 80½	74	6½	.17		
			p m 77½	p m 80	—	6	.15		
21	9 21 N	28 36 W	77½	77½	73¾	3¾	.10	NE	Moderate to brisk breeze, hazy to fair
				m 79½	74	5½	.14		
			p m 78½	p m 79½	74½	5	.13		
22	11 18 N	30 23 W	77½	77½	73½	4	.11	NE by E	Brisk breeze, fair to cloudy
			m 76½	m 78	72½	5½	.15		
				p m 76½	71½	5	.14		
23	13 10 N	31 18 W	75½	76	71½	4½	.13	ENE to E	Moderate to brisk breeze, cloudy
			m 75½	m 76½	—	5	.14		
				p m 75½	—	4	.12		
24	15 21 N	32 33 W	74½	74	70½	3½	.11	NE to NNE	Brisk breeze, cloudy
				m 75½	71½	4	.12		
			p m 74	p m 74½	71	3½	.11		
25	17 17 N	33 36 W	74	74	70	4	.12	E to ENE	Brisk to moderate breeze, clouds in triple tiers to fair, p m and n showers
			m 74	m 75	70½	4½	.13		
				p m 74	70	4	.12		
26	19 6 N	34 2 W	73	73	69	4	.12	ENE	Moderate, cloudy to fair
			2 p m 73½	m 74½	68½	6	.18		
27	20 54 N	34 53 W	73	72½	68½	4	.12	ENE to E	Moderate breeze, scattered fleecy clouds, and in triple series
				m 74	68½	5½	.17		
28	22 N	35 43 W	72	72½	67½	5	.16	E to ENE	Light breeze, clouds in double series, squalls passing, m rain
				9 a m 74	68	6	.18		
				m 71½	67½	4	.13		Mar. de Sargosa

			p m 72	p m 72	65	4	.12		
29	24 2 N	36 8 W	71	70½	66½	4	.13	E to ESE & variable	Moderate, cloudy to fair, squalls passing, n rain, with squalls
				m 73½	67½	6	.18		
			p m 72	p m 72	—	4½	.15		
30	25 52 N	36 27 W	71	71	68	3	.10	E to ENE and ESE	Moderate to light breeze, fair to cloudy, squalls frequent, a m rain
				m 72½	67½	5	.16		
			p m 73	p m 73	68½	4½	.11		
31	27 23 N	36 36 W	72½	71½	68	3½	.12	ESE to calm	Light airs, clouds to fair and clear
			m 73½	m 73½	66½	9	.27		
			p m 74½	p m 74½	66	8½	.26		
June 1	28 23 N	36 9 W	71½	71	65½	5½	.18	SSW to SW & variable	Moderate to fresh breeze, scattered clouds, a m and p m squalls, with rain
				p p 69½	67½	2	.07		
				m 71½	67½	4½	.14		
			2 p m 72½	73½	68	5½	.17		
			5 p m 71	70½	67	3½	.12		
2	30 28 N	35 14 W	70½	69	62	7	.23	Variable to NW and W to N	Moderate to fresh breezes, clouds to fair, m and 2 p m showers, squalls
				m 70	65½	4½	.16		
				p p 67½	—	2	.08		
				p m 69	63¼	6	.22		
3	31 58 N	33 39 W	69½	68½	64½	4	.15	N to variable NNW to NNE	Brisk to fresh breeze, scattered clouds to clear, squalls, m and n rain
				p p —	65½	2	.07		
			p m 69½	p m 70½	65½	5	.18		
4	32 50 N	34 08 W	69½	67½	63	4½	.16	NE to NNE	Brisk to light breeze, clouds to clear
			m 69	m 69	61½	7½	.27		
			p m 70	6 p m 67	60	7	.25		
5	33 28 N	35 17 W	70	67½	60½	7	.25	NNE to E and NE	Light airs to calm, passing clouds to clear
				m 69½	61½	8	.28		
			p m 70½	p m 68½	60½	8	.28		
6	33 41 N	35 08 W	69½	66½	59½	7	.26	Calm to WSW and SW	Light airs, clear
			m 71½	m 70	61½	8½	.30		
				sun 72					
				1 p m 69½	—	8	.23		
7	31 35 N	34 23 W	69½	67½	65½	2	.08	WNW to NW W & WSW	Moderate to fresh breezes, clouds, squalls
					pp66	1½	.06		
				10 am 69	—	3	.11		
				m 71	66½	4½	.16		
			p m 69½	7 p m 70½	67½	3	.11		

DIARY,—CONTINUED.

Date	Latitude	Longitude	Temp. Sea	Temp. Air	Dew	Dryness Fahr.	Dryness Cent.	Winds	Weather and Remarks
1822 June 8	35° 34′ N	33° 13′ W	67½°	67½°	63½°	4°	.15	NNE to NE and SE	Light breeze, sky overcast, 5 a m rain
				9 a m —	63	4½	.17		
				m 69½	63½	6	.22		
			p m 67½	3 p m —	64½	5	.19		
9	37 04 N	32 46 W	65½	63½	60½	5	.20	SE to SW	Moderate to fresh breeze, overcast sky to clear
			m 66½	m 68½	63½	5	19		
				p m 65½	61½	4	.16		
				6 p m —	62½	3	.12		
10	38 48 N	31 32 W	66	65¾	65	0¾	.03	SW to W	Moderate to light breeze, overcast sky to clear
				m 66½	65½	1	.04		
			p m 66	5 p m 67½	—	2	.08		
				sun 69					
				8 p m 66½	—	1	.04		
11	39 58 N	30 02 W	63¾	67	66	1	.04	SW to NW	Moderate to fresh breezes, hazy to foggy
				m —	65½	1½	.06		
			p m 64½	p m 63¾	64½	1¼	.05		
12	41 N	27 49 W	62½	61½	60¼	1¼	.05	N to NNE	Gale to strong and fresh breezes, cloudy
				m 62½	59½	3	.12		
				—	60½	2	.08		
13	41 5 N	25 33 W	61½	61¼	59½	2	.08	N to NNE & variable	Gale to strong and fresh breezes, clouds, squalls
				m 61¼	57¾	3½	.14		
				p m 61½	57	4½	.18		
14	41 30 N	24 14 W	61½	61½	59½	2	.08	N to NNE	Fresh and strong breezes, clouds, squalls, a little rain
				m 63½	—	4	.16		
				5 p m 62½	—	3	.12		
				7 p m 61½	57½	4	16		
15	42 52 N	22 27 W	60½	59½	56½	3		NNW	Strong to fresh breezes, clouds
				m 60½	—	4			
				5 p m 59½	55½	4			
16	43 32 N	20 55 W	59	58½	55½	3		NW	Fresh breezes, clouds, squalls with a little rain, 8 a m and m
				p p 57½	56½	1			
				—	55½	2			
				m 59½	—	4			

				p p 58½	56½	2			
			p m 59½	5 p m 61	—	4½			
17	44 25 N	19 32 W	60½	59½	55½	4		NNW to N	Moderate to fresh breezes, clouds, squalls, a little rain
				m 60	55¾	4¼			
				3 p m 61½	56	5½			
				sun 62½					
18	45 10 N	17 50 W	61½	61½	59½	2	.08	N to E	Moderate to light breezes, clear to thin clouds
				9 a m —	60½	1	.04		
			p m 61½	m 63½	—	3	.12		
				p m 62½	—	2	.08		
19	46 11 N	18 20 W	61½	62½	60½	2	.08	ENE	Moderate, clear to clouds, horizon hazy
			m 61½	m 64½	—	4	.16		
				p m 63½	59½	4	.16		
20	46 49 N	17 54 W	60½	61	56½	4½		NNE	Moderate, clouds, squalls, p m rain
				m 60½	—	4			
				p m 59½	57	2½			
21	46 28 N	16 19 W	61½	61	57½	3½		NNE to E	Moderate to light airs, clouds
				m 62	59	3	.12		
			p m 64½	6 p m 62½	59½	3	.12		
22	46 50 N	16 02 W	63¼	62½	59	3½	.14	Calm to W and NW to WSW	Calm to moderate, cloudy
			m 63½	m 63	58½	4½			
				5 p m 62½	57½	5			
23	48 16 N	14 01 W	63	62	60	2	.08	W to WSW	Strong breezes to moderate and calm, n squalls with rain, a m and p m fair
			m 64	m 64	61½	2½	.1		
			3 p m 64¼	3 p m 66½	—	5	.20		
24	48 41 N	13 14 W	63½	64	60	4	.16	NE to W and variable	Light airs to calm, fair to cloudy, 5 p m squall, with a little rain
			m 66	m 65½	—	5½	.22		
			3 p m 64½	3 p m 66½	61	5½	.22		
				7 p m 64½	60	4½	.18		
25	49 58 N	11 46 W	60½	60½	57	3½		WNW to SW	Fresh to strong breezes, fair to cloudy, overcast sky, 8 p m rain
				9 a m 61½	57½	4			
				m —	59½	2			
26	51 40 N		62½	62½	58½	4		WNW to N	Strong to fresh breezes, fair
				9 a m 61¼	—	2¾			
				m 61½	57½	4			
				3 p m 63½	59½	4			
				7 p m 62½	58	4½			
27			54½	55½	53½	2		N to W and SW	Fresh to light breezes, 8 p m rain
			m 57½	m 57½	—	4			
			3 p m 59		54	3½			

Art. X. ANALYSIS OF SCIENTIFIC BOOKS.

I. *Outlines of the Geology of England and Wales, with an introductory Compendium of the General Principles of that Science, and comparative Views of the Structure of Foreign Countries, illustrated by a coloured Map and Sections. By* the Rev. W. D. Conybeare, F.R.S., M.G.S., *&c.*; and William Phillips, F.L.S., M.G.S., *&c.*

We do not hesitate to pronounce this to be the best geological work extant; it presents the reader with a perspicuous statement of the uses and objects of geology, with a detailed and skilful account of the geology of England, and with much minute and practical information upon a variety of important subjects connected with the applications of the branch of science of which it treats. We are not, however, quite satisfied with the authors for publishing the first part, "without waiting for the completion of the second;" for the principal value of their work lies in the pleasure and information which it is calculated to afford to the geological traveller, who, unless he limit himself to the district included in this first volume, will frequently regret the necessity of proceeding upon his tour without the instructive company of these well-informed guides. It must, at the same time, be admitted, that the various members of the subject are, to a certain extent, independent of each other; and that one series of rocks may very well admit of study, without saying a word of those which precede or follow; so far, therefore, geology admits of that breach of continuity, of which Messrs. Conybeare and Phillips have availed themselves.

The part now submitted to the public comprises a description of all the strata which lie above the oldest rocks, associated with the coal district; and it is proposed, in the second part, to descend to the transition and primitive rocks, (as they are usually, but improperly, called,) and then to enter upon those incidental matters arising out of a general view of the subject, such as the history of the derangements which the strata or formations have experienced, together with an inquiry into their dates and causes; of the aspects and situations of valleys; and of the origin of those accumulations of pebbles and gravel which announce a great aqueous destruction of a former order of things.

In an introductory chapter, Mr. Conybeare has given the student some useful preliminary information, concerning the general position and arrangement of the strata, with a sketch of the rise and progress of geology, and brief notices of the chief writers upon the subject. Here we were glad to see justice done to Mr. William Smith, to whom we owe the first geological map of England, published in 1815, the result, we believe, of

five and twenty years' assiduous labour and study; and to Mr. Greenough, who, in 1819, published a map upon the same plan, but considerably improved as to minuteness and accuracy of detail. We could have wished, however, that the latter gentleman, instead of treading so closely upon Mr. Smith's plan, had given us the result of his accurate and diligent inquiries in the form of county maps; these might have been upon a larger scale, and would have admitted of all those minutiæ which render his map, valuable as it is, confused in its details, and laborious to consult.

The concluding portion of this introductory chapter, which relates to the connexion of geology with natural and revealed religion, we could have wished either altogether omitted, or more fully and competently discussed; but in relation to this subject we shall only refer our readers to Mr. Granville Penn's *Comparative Estimate of the Mineral and Mosaic Geologies*, a work abounding in sound doctrines, founded upon close reasoning, and admirably opposed to the tampering facility of some writers, and the scepticism and incredulity of others.

Our authors commence their work with an account, comprised in five chapters, of the Formations above the Chalk; these they call the "superior order," and had they strictly adhered to their plan of arrangement, they should have started at the surface, with the sandy deposits of rivers and streams; the accretions of springs; the accumulation of shingle along the sea-coast; the production of marsh-land, and other similar phenomena, which appear to have proceeded uninterruptedly, as at present, "from the period when our continents assumed their present form, and the actual system of what may be called geological causes, began to operate." They should also have given us the history of the beds of gravel, so remarkable for the remains of land animals of extinct species. They observe, however, in regard to these alluvial and diluvial deposits, that their history is so intimately connected with that of the strata which they cover, that it would scarcely be intelligible without reference to the parent rocks; they therefore refer the whole to an appendix, and defer it to the second volume.

The strata, properly so called, which lie above the chalk, consist of various beds of sand, clay, marl, and imperfectly consolidated limestone; these are every where bounded by a ridge of chalk, (except where the sea-coast interferes), which slanting off below the above-mentioned substances, forms a large concave area in which they seem to have been deposited, and hence the term *chalk basin*, of which the most northerly includes the metropolis, and has been called the *London basin*, while the southern is less properly termed the *Isle of Wight basin*, since it includes only the northern half of that island, which is traversed east and west by the edge of the basin.

The boundary of the first of these basins may be stated generally as a line running from the inner edge of the chalk, south of Flamborough-head, in Yorkshire, nearly south, till it crosses the Wash, then south-west to the upper part of the valley of the river Kennet, near Hungerford, in Wiltshire, and thence tending south-east to the north of the Thames, and the north-west angle of the Isle of Thanet; in all these directions the bounding line is formed by the chalk hills; on the east side the boundary is the coast of the German ocean.

The boundaries of the Isle of Wight basin may be generally assigned by the following four points: On the north, a few miles south of Winchester; on the south, a little north of Carisbrook, in the Isle of Wight; on the east, Brighton; and on the west, Dorchester. It is every where circumscribed by chalk-hills, excepting where broken into by the Channel between the Isle of Wight and the main-land.—P. 7.

Among the substances found in these basins, none are more remarkable than the strata of bluish or black clay, which, from its forming the general substratum of London and its vicinity, is usually called *London clay;* it occasionally includes calcareous and siliceous sand or sandstone; and in other countries the corresponding stratum is nearly entirely a calcareous freestone; such is the *calcaire grossier*, of which Paris is chiefly built.

This clay is with us remarkable for its horizontal layers of *septaria*, which are flattened masses of argillaceous limestone, traversed by veins of carbonate of lime, or sulphate of baryta. These nodules, when calcined and ground, form that very useful material for stucco and building under water, commonly known under the name of *Parker's Cement.* The London clay also affords specimens of blue pulverulent phosphate of iron, pyrites, amber, fossil resin, and selenite; the *hardness* of the water found in this stratum is chiefly referable to its containing the last-mentioned substance in solution. The blue clay is also abundant in organic remains of crocodiles, turtles, vertebral and crustaceous fish, and testaceous molluscæ in great number and beauty, but differing, though often very slightly, from recent genera; yet *extinct* genera, so common in the older formations, are rare in this; we believe, however, that cornua ammonis and belemnites have been found. Zoophytes are likewise of very rare occurrence. Among vegetable remains we here find pieces of wood in various states, and others perforated by teredines like those which infest the West Indian seas. In the Isle of Sheppey there have been found in these clay strata no less than 700 varieties of fruit and ligneous seed-vessels, very few of which agree with any known varieties at present in existence; some seem to be species of cocoa-nuts, and various spices. The greater part of the soil of Middlesex, Essex, and Suffolk, and considerable portions of Berkshire, Surrey, and Kent, consist of London clay; and in the Isle of Wight basin, it forms the whole coast from Worthing, in Sussex, to Christchurch, in Hampshire, and extends from the latter place, inland by Ringwood, Rumsay, Fareham, and passing a mile or two south of

Chichester to Worthing. The country is generally low, or only slightly undulated, and as a soil it is productive of fine oak, elm, and ash timber, but requires chalk to render it productive in corn; when well manured it forms excellent garden ground, as the vicinity of London amply testifies.

The history of the wells in London, is very interesting, as connected with the clay formation, and they may be divided into three classes. 1. Those which are in the gravel above the clay. 2. Those in the clay itself. 3. Those which derive their supply from the strata below the clay. A great deal of good limpid water is derived from the first class, where its escape is prevented by the dense nature of the substratum. Sometimes it is rather hard, and sometimes brackish, but generally speaking very good drinking water. This supply, however, though abundant, is generally insufficient for the consumption of our great manufactories; yet some of the large sugar-houses, distilleries, and breweries, exclusively employ the water of these shallow wells, which in some parts of the town are remarkably productive.

Where the diluvial gravel is very thin, or altogether wanting, there are wells sunk in the blue clay, but the water is extremely impure. Selenite is its common ingredient, and sometimes the pump delivers nearly a saturated solution of that salt. Sulphate of magnesia, sulphate of soda, sulphate of iron, and occasionally sulphuretted hydrogen, are also found in the waters from the blue clay. The supply of these wells is very precarious, and, literally speaking, very scanty; for they generally receive the drippings of the thin superincumbent diluvium.

The third class of London wells includes those which perforate the clay, and derive their water from the strata beneath it; these have lately become very numerous, and are truly important in many of our large manufactories which were before obliged to employ the muddy water of the Thames, or to submit to the capricious supplies and wanton impositions of the Water-Companies. The water which supplies these wells rises from the sands *below the London clay*; and if care be taken to exclude the impure springs which filter in from above, it is generally remarkably soft, excellently adapted for every domestic use, and, what is of principal importance, it never fails, and is not affected by rains or drought: traces of common salt and of carbonate of lime, are usually discoverable in it, but what is most remarkable is, that when evaporated it leaves a highly alkaline residue, chiefly of carbonate of soda, which sometimes amounts to four grains from the quart. The depth of these wells is, of course, dependant upon the thickness of the clay stratum. At White-Chapel, east of London, some wells have been carried through it, and do not exceed 100 feet; at Tottenham it is about 120 feet; at Messrs. Coutts and Co.'s banking-house in

the Strand, 200 feet; at White's club-house, in St. James's Street, 235 feet; at Chelmsford barracks 300 feet; and at Lord Spencer's, at Wimbledon, the well is 530 feet deep, and it is doubtful whether the clay is actually there pierced. By indirect examinations, the greatest thickness of the clay in the London basin has been estimated at 1000 feet, but this is mere guess. The height to which the water rises in these wells will depend much upon their locality. Upon perforating into the strata whence it issues, it generally rushes forth with violence, and assumes an invariable level; and there are several instances of its overflowing in a perpetual stream, of which the well at the late Mr. Goldsmid's, at Merton; that sunk by the late Mr. Vulliamy, at Norland-Hill, behind Holland-House, on the Uxbridge road; and that lately made at Ravenscourt, the seat of George Scott, Esq., at Hammersmith, may be quoted as instances.

Above the blue clay we find, in certain situations, distinct superimposed strata; thus on the east coast of Suffolk low cliffs resting upon the London clay are found to consist of sand and gravel, enclosing peculiar fossils; the whole mass is known by the appellation *crag*. Of the shells which it contains, the greater number resemble the recent shells of neighbouring seas; there are, however, a few extinct varieties, and among them the *murex contrarius*, or *reversed whelk*; though, what is very curious, the fossil shell with the whirls in the ordinary direction is also found here. There are likewise a few fossil bones, much impregnated with iron, and belonging to unknown animals. This formation is seen at Walton Naze, in Essex, and caps the cliffs on both sides of Harwich, extending considerably into Suffolk and Norfolk, where it forms a fertile soil. The sandy deposits which cover certain parts of the London clay, and which our authors denominate *Bagshot sand*, must also be considered among the deposits which geologists have lately termed the *Upper Marine formation*. Bagshot Heath, and the sand of Hampstead and Highgate, are of this description. It is, however, in the Isle of Wight that we meet with the most interesting series of the strata above the blue clay. For our knowledge of the curious arrangements and alternations of this district, we are exclusively indebted to the accurate and industrious researches of Mr. Thomas Webster, one of the Secretaries of the Geological Society. The cliff called Headen Hill, on the north-west coast of the island, exhibits an admirable section of these formations. This hill consists of several strata: the uppermost overlies the upper marine formation, and contains abundance of fresh water shells without any admixture of marine exuviæ, together with seeds of a flat oval form, and parts of coleopterous insects; it has been termed the *upper fresh-water formation*, and may be seen in many other parts of the island, es-

pecially about Cowes, Bembridge, and Binstead, and it is quarried as a building stone between Calbourne and Thorley. To this stratum succeeds the upper marine formation, and then we arrive at a series of beds of siliceous, calcareous, and argillaceous marls, abundant in fresh-water shells, but wholly deficient in marine relics; these beds constitute the LOWER *fresh water formation*, and may be seen extending round the north side of Headen Hill, into Totland Bay.

We now descend to the strata which lie immediately below the London clay. They consist of irregular alternations of sand, clay, and pebble beds, forming a series of contemporaneous depositions intermediate between the chalk and clay, and usually described under the very inappropriate term *plastic clay formation*. The sands are of various colours and qualities, so are the clays, some of which are used for pottery, some for tobacco-pipes, and some for bricks: they contain imperfect coal, pyrites, gypsum, and abundant organic remains in some places, while in others there are none. The highest northern point at which this formation is seen is near Hadleigh, in Essex, whence it borders the clay to about five miles south-west of Braintree. Halstead and Coggeshall, and the intermediate tract, are upon the plastic clay; it also extends from Ware to near Edmonton, over Enfield Chase, and passing close to St. Albans, skirts the London clay to Uxbridge, on the north of which it takes a westerly direction towards Beaconsfield, and thence runs nearly south to the Thames.

"It is seen again at Reading in Berkshire, and extends thence, though not in a straight line, to a few miles beyond Hungerford, which may be said to be its extreme point on the west, except a few outlying masses south of a line from the latter place to Marlborough in Wiltshire. Turning south from a little on the west of Hungerford, to the foot of the chalk hills, it passes east by Kingsclere, Basingstoke, and Odiham in Hants, and Guildford in Surrey; thence rather in a north-easterly direction a little to the south of Croydon, it continues to skirt the foot of the chalk hills by Farnborough and Chatham in Kent, and thence by Milton and Ospringe, to the foot of Boughton Hill, where it divides; passing on the one hand in a north-easterly direction, it skirts the London clay to Whitstable on the coast; and on the other nearly east to Canterbury, (which stands on the beds of this formation,) to the coast of the Reculver, whence again it passes to the south-west, except where marshy lands intervene, by Sandwich, which is built upon it, a little to the south of Deal."—p.p. 39, 40.

We now arrive at Book II. in which our authors describe what they call the *supermedial order* of rocks, comprising the several formations which intervene in descending from those which have been described in the former book, to the coal measures. These formations, though admitting of several subdivisions, may generally be referred to the following classes, enumerated in the order of their succession descending from the plastic clay. 1. Chalk. 2. Ferruginous sand. 3. Oolite, including lias. 4. New red sandstone and magnesian limestone.

The *chalk formation* from its extent and contents forms one of the most remarkable and interesting features of English geology. Where in contact with the superincumbent clay it generally exhibits symptoms of having been exposed and worn previous to its having received that covering, as if an interval had existed between its completion and the deposition of the formations that repose upon it. The upper strata of chalk are remarkable for their layers of nodular flints, which are generally arranged nearly in a horizontal position. Sometimes tabular masses, and even veins of flint, are observed, the latter traversing the strata at various angles. Nodules of pyrites, and of crystallized carbonate of lime are also found in these beds, and a very interesting series of organic remains of genera and species nearly all extinct. The lower strata of chalk are marked by the deficiency of flint and organic remains, and are commonly more or less argillaceous, exhaling an earthy smell when breathed upon, and degenerating into what is usually called *chalk marl*, a compound of chalk, clay and sand. Where chalk is of uniform texture, it is generally deficient in springs; but where it happens to be traversed by beds or veins of substances of softer or sabulous texture, there the water often percolates and yields an abundant supply. The agricultural qualities, and the aspect of chalk are too well known to require particular notice.

A loose siliceous sand, occasionally aggregated by a calcareous cement, and containing particles of mica and green earth, forms the stratum upon which the chalk rests, and which is of considerable thickness in the southern counties, but more obscure in the midland and northern counties. The fuller's earth, and sulphate of barytes of Nutfield in Surrey, together with crystals of quartz, and carbonate of lime, and nodules of chalcedony and chert, are found in this deposit; it is also very abundant in organic remains. It is, however, difficult to draw any correct line of demarcation between this *green sand* with its accompanying clays, and the great *iron sand* formation, which we see in such perfection in the cliffs at Hastings. This iron sand, however, is comparatively scanty in organic remains, so that the green sand and iron sand bear in this respect some analogy to the upper and lower chalk.

We are sorry that our limits prevent us following our authors into the valuable details, which they have selected with much judgment and diligence, connected with the localities of the chalk formation and its associates, but they do not admit of an intelligible abridgment: indeed, we think the work is occasionally a little obscured by an attempt at brevity; at least, by an endeavour to bring under one point of view a great assemblage of local peculiarities and minutiæ, many of which might have been more conveniently thrown into notes at the foot of the page, or

altogether omitted; as they now stand in the text, we should apprehend that they would perplex the student.

We now enter upon the third of the four subdivisions of the supermedial rocks, namely, the *oolitic series;* it is chiefly important as the great repository of the principal architectural materials which the island affords, and may be generally described as consisting of a series of alternating oolitic limestones, of calcareo-siliceous sandstones, and of argillaceous and argillo-calcareous beds, repeated in the same order. Three of these systems appear to comprehend all the beds which intervene between the iron sand and the new red sandstone, and each system lies upon a thick argillo-calcareous formation, constituting a well marked line of demarcation, the oolitic rocks of each system forming a distinct range of hills separated from those of the other systems by a broad argillaceous valley. In England, these formations occupy a zone having nearly thirty miles in average breadth, extending across the island from Yorkshire on the north-east, to Dorsetshire on the south-west; they are characterized by peculiar organic remains, among which we enumerate many extinct genera of oviparous quadrupeds, apparently inhabitants of salt-water only, various vertebral fishes, testacea of all descriptions, coralloid zoophytes, encrinites, &c. We give our authors great credit for the explicit, and yet condensed, account which they have given of the three oolitic systems. It embraces a clear view of all that has been done by others, enlightened by much original matter, well arranged, and luminously digested.

The whole of the oolitic series reposes upon argillaceous deposits, the uppermost of which are deep blue marl, with a few irregular beds of limestone, which increase in frequency as we descend, and present a series of thin stony beds separated by narrow argillaceous layers. These beds are known by the name of *lias;* they are argillo-calcareous, and the white varieties admit of polish, and may be used for lithographic engraving, while the blue or grey lias contains oxide of iron, and forms, when calcined, a strong lime, distinguished by its property of setting under water. The lias is nearly destitute of mineral products, if we except iron pyrites, which by its decomposition, frequently produces an aluminous efflorescence, as in the alum shale of Whitby, and sometimes a spontaneous inflammation, as in the cliffs near Charmouth. Organic remains are here very abundant and interesting; they embrace more vertebral animals than are found in any other formation; among them are two remarkably extinct genera of oviparous quadrupeds, the *ichthyosaurus*, and the *plesiosaurus;* the former has been described and figured by Sir Everard Home in the *Philosophical Transactions*, under the name of *proteosaurus;* they have both

been mistaken for crocodiles. The other organic relics in these strata are described at length by our authors; and here we cannot help smiling at human vanity, when we see such names as the following associated with an antediluvian ammonite! We have among the list of testaceous molluscæ the *Ammonites Walcotii, Brookii, Bucklandi, Greenoughii, Henleyi, Loscombi, Birchii, Bechei* and *Conybearei*: all this is very bad taste.

In the fourth chapter of this second book, our authors give a perspicuous description of the strata which intervene between the lias and the deposits of coal; these are referable to two formations very intimately connected together, *viz.*, 1. a series of marly and sandy beds, intermixed with conglomerates derived from older rocks, containing gypsum and rocksalt; and, secondly, a calcareous formation, often brecciated and containing magnesia, lying below or in the lower portion of the above series. The former deposits are commonly called *red marl*, or *new red sandstone*; the latter, *magnesian limestone.*

Red marl is a very extensive deposit, stretching from the northern bank of the Tees in Durham, to the southern coast of Devonshire; its texture is various, and it is especially remarkable for containing beds of *gypsum* and of *rocksalt*, and for the absence of organic remains.

In respect to the magnesian limestone, our authors remark, that much confusion has arisen from neglecting to distinguish between that associated with the red marl, and the older rock of similar composition associated with the mountain limestone, and from which it is distinguished by its organic remains and geographical position; the latter is also marked by the frequent occurrence of extensive beds of calcareous conglomerate. It differs from common limestone in having a sandy structure, glimmering lustre, and yellow buff or fawn colour; it often occurs in concretional masses, dispersed through an arenaceous form of similar materials; it is sometimes composed of small rhombic crystals; occasionally oolitic, and often cellular; that of Sunderland is flexible; at Ferrybridge it is fetid; and the lime which it affords, when calcined, is injurious as a manure, unless it be very sparingly employed. Organic remains are rare in this formation.

The third and last book of the present volume embraces the *carboniferous strata*, here called the *medial order* of rocks. The first chapter includes a general view of these formations; the second describes the coal district north of Trent; the third the central coal district; and the fourth the western coal district. In the fifth and sixth chapters, we have an account of the trap rocks occurring in the several coal districts above specified.

The series of rock formations included in the medial or carboniferous order, admit of the following subdivision: 1. Coal.

2. Millstone grit and shale. 3. Carboniferous, or mountain limestone. 4. Old red sandstone: and in forming an accurate notion of the geology of our coal districts, we shall be much assisted by keeping in view the mutual relations and connexions of these four substances; remembering, always, that although carbonaceous beds occur in other formations, it is only in the limits of the strata at which we have now arrived, that supplies of coal capable of being profitably worked are to be found.

The coal strata, or *coal measures*, as they are often called, "consist of a series of alternating beds of coal, slate-clay, and sandstone, the alternations being frequently and indefinitely repeated." The *slate-clay* or *shale* differs from clay slate by its want of solidity and induration; the sandstones are usually gritty, micaceous and tender; they are used for building, paving, and the manufacture of grindstones. These strata also afford nodules of clay ironstone, the ore, whence the principal supplies of that important metal are derived in this kingdom. "The occurrence," say our authors, "of this most useful of metals, in immediate connexion with the fuel requisite for its reduction, and the limestone which facilitates that reduction, is an instance of arrangement so happily suited to the purposes of human industry, that it can hardly be considered as recurring unnecessarily to final causes, if we conceive that this distribution of the rude materials of the earth, was determined with a view to the convenience of its inhabitants."

The organic remains of the coal strata are abundant and curious, especially those of the vegetable kingdom; they consist in the trunks, leaves, and seed vessels of various plants, all distinct from species now existing, but agreeing with the products of hot climates, and of moist situations; arundinaceous plants and ferns are very plentiful. The few shells that have been discovered are apparently marine, not fluvial.

The inclination of these strata is one of the most remarkable points in their geological history; they are generally inclined, and often at a very high angle, being quite unconformable to the more horizontal overlying beds; they also exhibit other irregularities, among which the great fissures which traverse them, often extending for several miles, deserve peculiar notice. These *faults* as they are provincially called, sometimes occasion a change of level exceeding 500 feet, one of the walls being elevated, or the other depressed to that amount, showing the agency of some violent convulsion which has thus divided the strata, and occasioned a tremendous vertical dislocation.

The coal measures rest upon beds of shale and of millstone grit, which is a coarse grained sandstone, more indurated than that which subdivides the strata of coal; it contains occasional beds of bituminous limestone, thin seams of an indifferent coal, nodules of ironstone, and abundance of pyrites, and is occa-

sionally visited by the metalliferous veins of the strata underneath. Various bituminous substances also are found in it, and abundance of vegetable impressions, together with some marine shells. Considered in a general point of view, this series is intermediate in character and composition, as it is in position, between the main coal measures which it supports, and the mountain lime which it covers, forming the natural link between them.

This whole series reposes upon an important assemblage of strata, chiefly calcareous, which our authors, from its association with coal, call *carboniferous limestone;* as it forms considerable hills, and is rich in metals, the terms *mountain* and *metalliferous* limestone have also been applied to it. Its prevailing colour is gray, and it is generally hard enough to take a good polish; it is often magnesian, ferruginous, and bituminous; its various strata being divided either by partings of clay, grit, or shale, or by alternations of that variety of trap rock, called in Derbyshire *toadstone.* It contains nodules of chert, arranged something like the flint in chalk, and it is remarkable for the prevalence of empty fissures and caverns; rivers which flow across it are often ingulphed, and pursue for a considerable distance a subterraneous course; it abounds in rocky dales and mural precipices, and forms much of the most picturesque and romantic scenery of England. It is, moreover, the principal depository of the British lead mines, those of Northumberland, Durham, Yorkshire, Derbyshire, and Cumberland, being all situated in it; it also affords ores of some other metals, and a variety of beautiful crystallized minerals. The organic remains of this limestone differ from those of the superincumbent strata, but resemble those of the inferior limestone, which our authors, following the nomenclature of the Wernerian school, call *transition limestone,* but which we can see no sufficient reason for considering as a distinct formation. This, however, as well as some other points upon which we feel inclined to differ with Messrs. Conybeare and Phillips, we shall take occasion to advert to in our notice of their second volume. Vertebral remains, though rare, are found here; there are also many species of *testacea;* zoophytes, and especially encrinites and corallites, are profusely abundant; and indeed the whole mass of rock sometimes seems as if entirely made up of them, whence it has been called *encrinal limestone.* The strata of carboniferous limestone exhibit all the irregularities of the accompanying coal measures; they are often greatly inclined, contorted, and dislocated; and, when they alternate with argillaceous strata, they generally abound in springs, which break out often with singular impetuosity. The hot springs of Buxton, Matlock, and Clifton, are upon this formation; the waters are generally remarkably pure and pellucid, though sometimes so

loaded with carbonate of lime, held in solution by excess of carbonic acid, as to deposit it as a tufa upon the adjacent rock, or incrust substances accidentally immersed; such are the *petrifying springs* of Matlock, Middleton, &c.

We now reach the lowest member of the carboniferous or medial series of rocks, which, from its priority of deposition, is termed *old red sandstone;* it is sometimes separated from the limestone by a layer of shale; it is a mechanical aggregate, constituted apparently of abraded quartz, mica, and felspar, containing fragments of quartz and slate; sometimes its texture is slaty and fine grained; at others it passes into a conglomerate. Its colour is dark iron-red, brown, or gray, and it usually passes in its lower strata, by an insensible gradation, into the greywacke upon which it is generally observed to repose. It contains few organic remains, and no important minerals.

To this outline of the rocks associated in the carboniferous order, our authors subjoin an excellent abstract of their peculiarities in the principal coal districts, and conclude their volume with an account of the Trap Rocks occurring in association with the coal measures. This seems to us the only objectionable chapter in the book; and as they must necessarily recur again and again to this curious and important series, and to the phenomena which accompany them, we could wish that they had not broken in upon the subject in a partial and unsatisfactory manner. Our readers will have observed that the formations hitherto described, and properly enough termed *strata,* follow each other as successive deposits, in regular and unvarying order; but not so with the trap rocks; they make their occasional appearance amidst all the strata, from the chalk downwards; not as regular formations, but as invading masses, dislocating and disjointing their neighbours, converting chalk into marble, sandstone into chert and jasper, coal into coak, and shale into siliceous shist; they occasion dykes, or *faults* and elevations of the strata, and bear every mark of igneous origin, and of violent and sudden assumption of their present situation; among the older rocks, they also play a very important part, and their general history tends to clear up many difficulties connected with the granitic formations. We, therefore, anxiously look for our authors' second volume, in which these and many other intricate and anomalous, but highly interesting and important, geological phenomena must necessarily be discussed at length.' These circumstances, therefore, induce us to defer an account of the pranks and irregularities of the trap rocks, and of the confusion which they create among the coal strata, until we are called upon more formally to contemplate their singularities, and to endeavour to trace their origin and effects, with the whole mass of information which the subject requires before us.

We have now presented our readers with an outline of the arrangement and contents of this valuable work, in the hope that its perusal may induce them to refer to the original, and that it may usefully direct their notice to the main points and grand divisions of geological study. We must, at the same time, confess that we have entirely passed over much valuable information, especially that relating to the foreign localities of .ocks, with a view of rendering our account of the work as perspicuous as lay in our power, and of directing the student to the great landmarks which principally call for his undivided attention. One observation we ask leave to suggest to the authors, which is, whether they have not occasionally obscured their narrative, by long lists of organic remains, repulsive from their crabbed orthography, and unintelligible to the geological student in their present unillustrated form? We do not mean to undervalue these catalogues, but think they would have been better placed in an Appendix, or as notes. At the same time, there are, in other places, so many useful and interesting pieces of information distributed through the notes, that we could wish to see them promoted to the superincumbent text. We also think that the pains which are taken to assign to each author his respective contributions, give the book, in some places, an air of affectation, and in others of confusion and circumlocution. Mr. Phillips's former work has amply published his claims to the merit of a skilful compiler and accurate observer; and the improved features of the present "Outlines," the general clearness of the arrangement, and, above all, the important practical details and local illustrations which they contain, sufficiently shew how much he is indebted to the zeal and information of his reverend coadjutor.

II. *Conversations on Mineralogy, with Plates, engraved by* Mr. *and* Miss Lowry, *from Original Drawings.* In 2 vols., 1822.

Foreigners shall no longer accuse the English of taciturnity; we have Conversations on Chemistry,—Conversations on Natural History,—Conversations on Political Economy,—Conversations on Mineralogy,—and, to crown all, Conversations on Algebra! The first of these in the order of appearance, as well as merit, were the Conversations on Chemistry,—a delightful little work, most admirably adapted to its purpose, the initiation of young persons in the elements of that alluring science. Its success *almost* equalled its merit, and we do not wonder that the rapid sale of edition after edition, to the present eighth of this, A.D. 1822, should have induced suc-

ceeding authors to adopt a similar method for teaching the rudiments of the other sciences.

Amongst these, Miss Delvalle Lowry has lately favoured us with the *Conversations on Mineralogy.* Whether she has followed in the path of her deservedly celebrated prototype, *passibus æquis,* or talked as *much to the purpose* on the subject of mineralogy, as Mrs. Marcet has done on that of chemistry, it now becomes our business to inquire, by examining the contents of the two little volumes before us. Of this we are convinced, that every work, which, like Mrs. Marcet's, tends to accustom the young mind to a connected train of thinking, and by easy and familiar, yet not frivolous, means, brings it acquainted with the sciences, does almost incalculable good, and the sooner such works are put into the hands of young persons, after they have attained their ninth or tenth year, the better; for as we have no faith in the wild reveries of craniological infatuation, we are of opinion that the early impressions of infancy often retain a lasting influence on the mind, and that the plaything philosophy of the nursery, may stamp the future character of a Newton or a Cavendish.

But to return to Miss Lowry.

The first volume contains nine conversations. The subject of the first is introductory, and consists principally of the Definition of Mineralogy,—the distinction between it and geology,—its relation to chemistry and the elements of minerals. In the definition, mineralogy is said to be divided into oryctognosy, "or a knowledge of minerals by their external characters," chemical mineralogy, and geology.

There is more parade than profit in this distinction. Mineralogy and geology are quite sufficient without oryctognosy—a lately introduced and bad term, derived from ορυσσω, *fodio,* and γινωσκω, *nosco,* meaning, if it mean any thing, the science of digging, and consequently as applicable "to potatoes and carrots," as to metals and stones. We notice this, because it may mislead the young reader, in writing for whom more than common care should be taken not to introduce terms calculated to give false ideas, (nor new ones at all, unless absolutely necessary,) which, if etymology have any thing to do with the *application* of a term, is eminently the case here, for by no possible construction can *oryctognosy* (etymologically) be made to signify "a knowledge of minerals by their external character." A similar complaint might be made against some of our author's chemistry; for instance, speaking of diamonds, she says—"You will hardly credit me when I tell you, that they are nothing more than charcoal;" and immediately afterwards, "We are certain that they *are* charcoal, though not in the state in which we generally see it." We are certain, on the contrary, that they are *not* charcoal. Charcoal and diamond

contain a common element, and no other than *carbon* has been hitherto detected in the diamond; but in charcoal, and also in plumbago, chlorine detects a portion of hydrogen, to whatever heat they may have been previously exposed; whence the inference seems irresistible, that hydrogen is an essential ingredient in those two substances, and, consequently, that a difference actually exists, in point of chemical composition, between the former and diamond. Our fair authoress would have done better, therefore, not to have asserted their identity in quite so decided terms. We recommend her to look a little more into the *Conversations on Chemistry* before her second edition is published, where she will find the difference between *charcoal* and *pure carbon*. The *latter*, indeed, in its crystalline form, constitutes diamond *. In the list of metals, *wodanium* is introduced, which Stromeyer's experiments have pretty sufficiently shewn never had any existence but in the mistake of its discoverer, Lampadius. In the second conversation, the consideration of the chemical properties of the elements of minerals is continued, and one or two more instances of error in our author's chemistry occur; for instance, *fluorine* is called a *gas*, whereas it is the unknown base of fluoric acid, and consequently we are ignorant what form it would assume if we could insulate it. In combination with silicium and boron, it constitutes the fluosilicic, and fluoboric acid gases. The compound of fluorine and hydrogen, in its purest form, is liquid at the temperature of 60° Fahr.

Speaking of ammonia, she says, " its precise nature is not well known, but it is suspected to consist of hydrogen, oxygen, and nitrogen." We do not know who entertains such a suspicion. Nitrogen has been supposed to consist of an unknown base and oxygen, and, because it suits his chemical canon, Berzelius has assumed it as a fact, and in the tables at the end of his Essay on the Theory of Chemical Proportions, has given the composition of ammonia, as consisting of one atom of *nitricum* (his imaginary base of nitrogen,) one of oxygen, and six of hydrogen; but no one, that we know of, has supposed it to contain both nitrogen and oxygen. Putting hypothesis out of the question, ammonia is well known to consist of one volume of nitrogen and three volumes of hydrogen, condensed into two volumes.

The third conversation treats of specific gravity, of the hydrostatic balance, of the metals that are, and one that is not, (*wodanium*) of their comparative utility, and of the external and physical characters of minerals. This is a pleasing and instructive conversation, from which the young reader cannot

* In vol. ii., p. 2, the expression is more accurate, where diamond is said to be " *nearly* the same substance as charcoal."

fail to derive a great deal of valuable information. We wish wodanium had been omitted.

The fourth and fifth conversations contain the continuation of the external characters,—Crystallography; the Goniometer, common and reflective, and their uses; irregular external forms of Minerals; Transparency, and other characters, as fracture, cleavage, &c.; use of the Electrometer; Magnetism; and the use of the Blow-pipe, Fluxes, &c. These also are instructive conversations. The derivation of a secondary crystal from the primitive form, is clearly and familiarly explained, by references to several figures of dissected crystals, which are executed with that accuracy and elegance that distinguish the works of Mr. and Miss Lowry. Indeed the whole of the figures, of which there are no fewer than 403, do them great credit. All, except the first 31, are outline engravings of crystalline forms.

The sixth conversation begins the more immediate subject of mineralogy. Of her arrangement we shall let Miss Lowry speak for herself.

Every system of mineralogy must be founded either on the chemical, or on the physical, characters of minerals, or on a combination of both. The latter are the most convenient (if not the most useful,) and, therefore, are most generally adopted; but there is a great diversity of opinion on an important question which naturally suggests itself, where to begin? The French mineralogists, who have paid great attention to the crystallization * of minerals, considering it as their most important character, have in general placed at the beginning of their systems those minerals which are composed of an earth and an acid. The mineralogists of the German school appear to have selected a substance arbitrarily as the first in their arrangements, and to have formed their genera and families with much less regard to the chemical, than to the physical, characters; and even amongst these, have paid least attention to that which is certainly, where it exists, the most unvarying; I mean crystalline form. But I think we should try to discover whether there is (*be*) not any kind of *natural* order, which might, at least, in *some degree* be observed in the formation of a system.......

We know that the great masses which constitute the crust of the globe are chiefly earths; these are by far more abundant than the metallic, alkaline, or inflammable substances, and are considered to be in general more ancient......

I therefore begin with silica (in its purest form,) as it is the most ancient and most abundant of all mineral substances. Minerals are frequently divided into four classes, *viz.*, the earthy, the saline, the metallic, and the inflammable † minerals.

Many celebrated mineralogists, however, subdivide the first class into *earthy* and *acidiferous earthy* minerals, which renders the arrangement rather more chemical, and which I have adopted.——p. 101—103.

To this we subjoin an outline of the tabular view of her arrangement.

* "It is to the Abbé Haüy that we are indebted for the explanatory theory of the structure of crystals."

† "Inflammable and combustible are not synonymous terms. All metals are combustible; that is capable of uniting with oxygen; but they will not burn in atmospheric air, and are, therefore, not called inflammable."

The earthy class contains two orders (as just stated.) The first includes earthy minerals, which are divided into five *genera* —the *Siliceous*, *Magnesian*, *Aluminous*, *Zirconian*, and *Glucinian*. The first *genus* contains 15 families, *viz.*, Flint, Garnet, Idocrase, Schorl, Epidote, Pitchstone, Zeolite, Lasulite, Felspar, Mica, Slate, Clay, Lithomarge, Hornblende, and Augite.

The second *genus* contains three families :—Magnesite, Talc, and Chrysolite. The third *genus* has four families :—Ruby, Nepheline, Topaz, Cyanite ; and the fourth and fifth *genera* one each, *viz.*, Zircon and Glucine.

The second order, Acidiferous Earthy Minerals, has also five *genera* :—1. *Calcareous*, containing the following families :— Carbonates, Phosphates, Fluates, Sulphates, Borosilicates, Tungstates, Arseniates, Silicates. 2. *Aluminous*—Sulphates, Phosphates, Fluates, Mellates. 3. *Magnesian*—Carbonates, Sulphates, Borates, Silicates. 4. *Barytic*—Carbonates, Sulphates. 5. *Strontitic*—Carbonates, Sulphates. The Alcaline Class has three *genera*. 1. *Salts of Potash*—Nitrates. 2. *Salts of Soda*— Carbonates, Sulphates, Muriates, Borates. 3. *Salts of Ammonia* —Sulphates, Muriates.

The Metallic Class contains 23 *genera*. 1. *Gold*—Alloys. 2. *Platinum*. 3. *Palladium*. 4. *Iridium*. 5. *Tellurium*. 6. *Mercury*—Alloys, Sulphurets, Chloride. 7. *Silver*—Alloys, Sulphurets, Oxides ? Chlorides, Salts. 8. *Copper*—Alloys, Sulphurets, Oxides, Salts. 9. *Iron*—Alloys, Sulphurets, Oxides, Salts. 10. *Manganese*—Oxides, Salts. 11. *Uranium*—Oxides. 12. *Cerium*—Salts. 13. *Tantalum*—Oxides. 14. *Cobalt*—Alloys, Sulphurets, Oxides, Salts. 15. *Nickel*—Alloys, Oxides, Salts. 16. *Molybdenum*—Sulphurets, Oxides. 17. *Tin*—Sulphurets, Oxides. 18. *Titanium*—Oxides, Salts. 19. *Zinc*— Sulphurets, Oxides, Salts. 20. *Bismuth*—Alloys, Sulphurets, Oxides. 21. *Lead*—Alloys, Sulphurets, Oxides, Salts. 22. *Antimony*—Alloys, Sulphurets, Oxides. 23. *Arsenic*—Alloys, Sulphurets, Oxides.

The Inflammable Class contains four *genera*. 1. *Carbonaceous* —Diamond, Graphite. 2. *Bituminous*—Bitumen, Coal. 3. *Resins*. 4. *Sulphur*.

Under each family are included the species, in many cases numerous, but which our limits will not allow us to insert here. When two or more minerals have considerable resemblance to one another, their distinguishing characters are generally well given. The following passages will serve at once as instances of this, and as fair specimens of the style of the work.

Page 181. *Mary*. Are these large crystals epidote ?

Mrs. L. Yes ; its most common colour is deep pistachio green ; and the large crystals and massive epidote, are only translucent on the edges ; the primitive form is a right prism, of which the bases are oblique angled parallelograms, but they are rarely if ever found without modifications.

P. 183. Zoisite very much resembles epidote in some respects, and the constituent parts are nearly the same, but its colour is generally bluish or yellowish gray, sometimes inclining to brown.

Frances. I think the fracture is brighter than the epidote.

Mrs. L. The most distinctive character of zoisite, is the manner in which the prismatic crystals are aggregated, like a parcel of reeds beside each other, and sometimes slightly diverging. It has but one cleavage, which is parallel to the axis of the prism, and in the direction of the shorter diagonal of the base.

P. 235. Hornblende, actinolite, and tremolite, are in some respects so much alike, that many mineralogists consider them as varieties of the same substance, their difference being chiefly occasioned by the nature of the minerals in which they are imbedded; but as this cause produces great difference of colour, and even of composition, it will perhaps be better to divide them.

Frances. But would not the form of the crystals decide this question?

Mrs. L. Their crystallization has, ultimately, shown their connexion: but the first crystals of tremolite that were examined, not being very perfect, their angles were found by the common goniometer, (which was the only one then known,) to differ from those of hornblende and actinolite by, I think, two degrees. I speak of the angles of the prism, which was supposed to be the primitive form, for the *terminations* of the crystals were altogether different from those of hornblende. The examination of other crystals has since proved that the primitive form of all the three species is an oblique prism, of which the incidencies of the lateral planes are 124° 36′, and 55° 24′, by the reflecting goniometer.

Mary. From what you have said, I suppose these minerals pass into each other.

Mrs. L. Yes, they do, in every respect. Actinolite is intermediate between hornblende, which is generally black, or very dark green, and tremolite, which is always a light-coloured mineral. Actinolite is always green.

P. 247.—*Mary.* I recollect you told us that talc might be distinguished from mica by being flexible, but not elastic; but when the laminæ are so small as in this specimen, you would not be able to see whether they were elastic.

Mrs. L. Perhaps not, but talc and mica differ in other particulars, as well as their degree of flexibility. If you try to scratch mica, you will feel a harsh grating sensation; but talc is very soft and soapy, yielding to the pressure of the nail with ease. This is the case even with indurated, as well as foliated and earthy talc; besides, the lustre is more pearly than that of mica, and in general the colour is white or green.

Frances. This is a beautiful bright green, but I do not see any large folia, like your Siberian mica.

Mrs. L. No; the laminæ of talc rarely exceeds a few inches in size. When it is crystallized, which is more rarely the case than with mica, it has the same form as mica. The substance commonly called French chalk is indurated talc.

A few puerilities now and then occur, which perhaps the plan of the work has almost unavoidably introduced, and may be some objection to the plan itself, for, if necessary to the *keeping* of the piece, they imply an infantine state of intellect, ill adapted to the comprehension of the more difficult parts of the subject. The style, as our extracts have shewn, is easy, clear, and unaffected. There are two appendices at the end of the work, one containing the tabular arrangement of the subject, the other an exceedingly useful, "Alphabetical list of one hundred and eighty-seven names of minerals, with their

derivations from the Greek, Latin, and German." In the latter, Miss Lowry was assisted by Mr. Heuland; of their accuracy therefore there can be no doubt; but we wish the "classical friends" who furnished her with the Greek derivations, had taken a little more pains on the subject. Several etymological errors have crept into this list, and one or two into the body of the work, which we notice, not from a desire to censure, but solely with the hope of seeing them corrected in a future edition. Vol. i. p. 67.—γωνια is an angle, not γονος, which is derived from γινομαι, nascor, and means offspring, or progeny. In a note, vol. ii. p. 13, Cyanite is directed to be pronounced Kyanite. This is a mistake; the Greek *k* is always rendered in English by *c*, and before the vowels *e*, *i*, and *y*, has the sound of *s*, as in cymbal, circus, cistus, &c., not kymbal, kircus, and kistus.

Amethyst, μεθυσος is drunk, not μεθυστος.

Analcime, not from ανα, and αλκη, but ανευ, absque; or from α. *not*, with the ν added, for the sake of the euphony.

Anhydrite—a similar error.

Datholite, θολος, is turbid—δαθολος, *very* turbid.

Eudyalite, from ευ, bene, and δυω, *subeo*; or, more probably, δευω, to moisten. We are not aware that δυω ever signifies to *vanish*.

Gypsum—γυψος is an original word; γυψοω means to plaster with gypsum.

Paranthine—the preposition παρα, which, in composition, means beyond, except, at, &c., can hardly be translated "*exposed*." In the present instance it seems to signify *instar*, similitude.

But these are trifling mistakes, and easily corrected. We would also recommend that the introduction of a fresh mineral, should begin a fresh paragraph, and not commence, as generally happens, in the middle of a line, as if it were the continuation of the preceding subject. It would look better, and be useful in reference.

On the whole, the *Conversations on Mineralogy* have strong claims to our praise; they contain a great deal of valuable information, delivered in a very pleasing language. The work is often enlivened by descriptions of the uses to which many of the minerals are applied, both in the arts and the common purposes of domestic economy, and cannot fail to stimulate the young mineralogist, who studies it with the attention it deserves, to pursue the science with ardour and success.

III. *Philosophical Transactions of the Royal Society of London, for the year* MDCCCXXII. PART I.

This part of the *Philosophical Transactions* made its appearance in June last; it contains eighteen communications upon

various branches of physical science, and is illustrated by no less than twenty-nine engravings. We shall, as usual, enumerate the papers in the order of their arrangement, giving a more or less extensive abstract of each, according to its merits and importance.

1. *The Bakerian Lecture. An account of Experiments to determine the amount of the Dip of the Magnetic Needle in London, in August* 1821*; with Remarks on the Instruments which are usually employed in such determinations. By* Captain Edward Sabine, of the Royal Regiment of Artillery, F.R.S.

The instruments in general use for ascertaining the dip of the magnetic needle, have received little improvement for the last fifty years, and are subject to various sources of inaccuracy, many of which are without remedy. Convinced, from the trial of several needles, that their discordant results were chiefly referable to inaccuracy in the motion of the axis, our author requested Mr. Dollond to make a needle on a constiuction suggested from similar experience by Professor Mayer, of Gottingen, but with certain alterations and improvements, which, together with the mode of observation, are described at the outset of the paper. The experiments were made in the Nursery Garden, in the Regent's Park, " a situation far removed from the neighbourhood of iron," and their mean result gives 70° 03′, as the mean dip of the needle towards the north, in August and September, 1821, within four hours of noon, being the limit within which all the experiments were made. Comparing this amount with that obtained by Nairne in 1772, and by Cavendish in 1776, we obtain 3′.02 as a mean annual rate of diminution between 1774 and 1821, which is less by 2-5ths than the mean annual diminution at Paris, between the years 1798 and 1814, as deduced from the observations of Messrs. Humboldt, Gay-Lussac, and Arago, whence it might be inferred, if sufficient dependance could be placed upon the accuracy of the observations, that the annual variation of the dip in this part of the world, is greater now than it was forty years ago; yet if we take Whiston's determination of the dip in 1720, 75° 10′, we obtain, between the years 1720 and 1724, an annual diminution of 3′.05, which almost exactly coincides with the rate now found for the succeeding forty-seven years.

2. *Some Positions respecting the Influence of the Voltaic Battery, in obviating the effects of the division of the Eighth Pair of Nerves. Drawn up by* A. P. Wilson Philip, M.D., F.R.S., Edinburgh. Communicated by B. C. Brodie, Esq., F.R.S.

Our high opinion of the importance of Dr. Wilson Philip's physiological researches may be judged of, by the space which we frequently devote to them in this Journal. The short paper

now before us appears to us to contain, along with several curious observations, two discoveries of the first magnitude, as connected with the laws of animal life; the first is, that when the nerves of the eighth pair are divided in the neck of a rabbit, *and the ends not displaced*, the animal being allowed to live for some hours, it was found that food swallowed immediately before the division of the nerves, *was considerably digested, even when the divided ends of the nerves had retracted to the distance of a quarter of an inch from each other.* When, however, the divided ends of the nerves *were turned completely away from each other, no perfectly digested food was found*, the animal having been kept alive as before. In an experiment, in which, under such circumstances, the stomach was exposed, from the time of the division of the nerves, *to the influence of a voltaic battery sent through the lower portion of the divided nerves, its contents were apparently as much changed as they would have been in the same time in the healthy animal.* If no source of error has crept into these inquiries, and we are told by Dr. Philip that the experiments were made with Mr. Brodie's assistance, and that, with respect to the results, Mr. Brodie agrees with him, (and we consider Mr. Brodie to be very high authority here) we repeat that Dr. Philip has established two entirely new and important physiological facts, sufficient to place him high among the discoverers of the age; the first is, that the nervous energy, or power, is not entirely interrupted or cut off when the nerve is divided, provided its divided ends be not forcibly and extensively separated from each other; the second, that electricity is capable, under certain circumstances, of causing the extremity of the divided nerve to maintain the most essential of those functions which it enjoyed in an undivided state.

3. *On some Alvine Concretions, found in the Colon of a young Man in Lancashire, after Death. By* J. G. Children, Esq., F.R.S. Communicated by the Society for promoting Animal Chemistry.

Mr. Children here relates the case of a young man, who, during the hot weather of July, 1814, was in the habit of eating large quantities of unripe plums, and swallowing the stones, under the notion that they would assist digestion. This is often done with impunity, but the danger of the practice is shewn in the unfortunate person before us, whose health became seriously disordered in February, 1815, and he lingered in great suffering till the 6th of May following, on which day he expired. His symptoms were diarrhœa, pain and tension of the abdomen, emaciation, and a hard circumscribed tumour in the region of the colon. On opening the body, four concretions were found in the arch of the colon; three closely compacted together, the fourth lower, and near the termination of that intestine. Their

total weight was nearly five ounces; plum-stones were found in their centres, while the bulk of the concretions consisted of phosphate of lime and ammoniaco-magnesian phosphate, a large portion of animal matter, and a fine fibrous substance derived from the oat, oatmeal having formed a large part of his food during his illness. Mr. Children concludes this paper with detailing the method of analysis which he pursued, and with a reference to some similar cases.

4. *On the Concentric Adjustment of a Triple Object-glass. By* William Hyde Wollaston, M.D., V.P.R.S.

The centring of a triple achromatic object-glass has always presented considerable difficulties to practical opticians: these, with his usual skill and ingenuity, Dr. Wollaston succeeded in removing with regard to an excellent telescope in his own possession, by observing the relative position of the fifteen small images of a luminous object near the eye-glass, which are formed by the binary combination of the reflections of the six surfaces concerned, and which are seen by an eye situated beyond the object-glass, and assisted, if required, by a lens. When these images are all in the same right line, it is obvious that the glasses are not only well adjusted together, but that each is well centred; and by means of four screws acting on each glass, Dr. Wollaston was able to make the adjustment so complete as considerably to improve the powers of the instrument. A illustrative plate is annexed to this paper.

5. *On a new species of Rhinoceros, found in the interior of Africa, the Skull of which bears a close resemblance to that found in a fossil state in Siberia and other countries. By* Sir Everard Home, Bart., V.P.R.S.

It has been hitherto asserted, (says Sir Everard) as one of the most curious circumstances in the history of the earth, that all the bones that are found in a fossil state, differ from those belonging to animals now in existence; and I believe that this is generally admitted, and that there is no fact upon record, by which it has been absolutely contradicted; but the observations I am about to state respecting this rhinoceros, illustrated by the drawings that accompany them, will go a great way to stagger our belief upon this subject.

The skull of this rhinoceros was brought to England by Mr. Campbell, who shot the animal about 250 or 303 miles, up from the westward of De la Goa Bay, six miles west of the city Mashow, and above 1000 miles in nearly a straight direction from the Cape of Good Hope.

The country from whence the rhinoceros comes, contains no thick woods, or forests, but is covered with separate clumps of trees, like a nobleman's park in England. In travelling, you always appear to be approaching a wood; but as you advance, the trees are discovered to stand at a distance from one another, or rather in little clumps.

This animal feeds upon grass and bushes; is not carnivorous, and not gregarious; seldom more than a pair are seen together, or in the vicinity of one another. Mr. Campbell's people wounded another of the same

description. When enraged it runs in a direct line, ploughing the ground with its horn. The hide is not welted, is of a dark brown colour, smooth, and without hair.

Sir Everard then proceeds to describe the skull, and especially to point out its exact resemblance to the fossil skull from Siberia, whence he concludes—That although many animals belonging to former ages may be extinct, they are not necessarily so; no change having taken place in our globe, which had destroyed all existing animals, and therefore many of them may be actually in being, although we have not been able to discover them.

Our author then adverts to the immense tracts of Africa which remain unexplored, and to the probability that they form the retiring places of animals not disposed to submit to the will of man; he quotes the following document to show in what way particular animals may elude our inquiry at one time, and at another be brought within our reach.

Mr. Campbell says, he found that the wild ass, or quagga, migrates in winter from the tropics, to the vicinity of the Malaleveen river, which, though farther to the south, is reported to be warmer than within the tropic of Capricorn, when the sun has retired to the northern hemisphere. He saw bands of two or three hundred, all travelling south, when on his return from the vicinity of the tropic; and various Bushmen, as he proceeded south, inquired if the quaggas were coming. Their stay lasts from two to three months, which in that part of Africa is called the Bushmen's harvest. The lions who follow them are the chief butchers. During that season, the first thing a Bushman does on awaking, is to look to the heavens to discover vultures hovering at an immense height; under any of them he is sure to find a quagga that had been slain by a lion in the night.

The author then goes on to draw a comparison between the docility of the elephant, the horse, and the rhinoceros, and refers the untameableness of the latter to the smallness of its brain; he concludes his paper as follows:

The following account of the manners and habits of the Asiatic rhinoceros, clothed in armour, and having the welted hide, I have taken from the young man who was its keeper for three years in the Menagerie at Exeter Change, at the end of which period it died.

It was so savage that, about a month after it came to Exeter Change, it endeavoured to kill the keeper, and nearly succeeded. It ran at him with the greatest impetuosity, but fortunately the horn passed between his thighs, and threw the keeper on its head; the horn came against a wooden partition, into which the animal had forced it to such a depth, as to be unable for a minute to withdraw it, and during this interval the man escaped.

Its skin, although apparently so hard, is only covered with small scales, of the thickness of paper, with the appearance of tortoise shell; at the edges of these, the skin itself is exceedingly sensible, either to the bite of a fly, or the lash of a whip; and the only mode of managing it at all was by means of a short whip. By this discipline the keeper got the management of it, and the animal was brought to know him: but frequently, more especially in the middle of the night, fits of phrensy came on, and while these lasted nothing could control its rage, the rhinoceros running with great swiftness round the den, playing all kinds of antics, making hideous noises, knocking every thing to pieces, disturbing the whole neighbourhood, then all at once becoming quiet. While the fit was on, even the keeper

durst not make his approach. The animal fell upon its knees to enable the horn to bear upon any object. It was quick in all its motions; ate ravenously all kinds of vegetables, appearing to have no selection. They fed it on branches of the willow. It possessed little or no memory, dunged in one place, and, if not prevented, ate the dung, or spread it over the sides of the wall. Three years' confinement made no alteration in its habits.

The account in the Bible of an unicorn not to be tamed, mentioned by Job, bears so great an affinity to this animal, that there is much reason to believe that it is the same, more especially, as no other animal has ever been described so devoid of intellect. In that age, the short horn might readily be overlooked, as it cannot be considered as an offensive weapon, and the smoothness of the animal's skin would give a greater resemblance to the horse than to any other animal.

6. *Extract of a Letter from* Capt. Basil Hall, R.N., F.R.S., to W. H. Wollaston, M.D , V.P.R.S., *containing Observations of a Comet seen at Valparaiso.*

7. *Elements of the above Comet. By* J. Brinkley, D.D., F.R.S., &c

This comet was in sight for thirty-three days, but Capt. Hall, being in the interior of the country when it first appeared, made no accurate observations till the 8th of April; it was then distant nearly 1.41 from the earth, the sun's distance from the earth being $=1$. On the 3d of May, when last seen, its distance was $=2.64$. This comet is interesting to astronomers from its small perihelion distance, and from the probability that it is the same that was observed in 1593, which agrees with this in its small perihelion distance, and great inclination.

8. *On the Electric Phenomena exhibited in Vacuo. By* Sir Humphry Davy, Bart., P.R.S.

Is electricity a subtile fluid, or are its effects merely the exhibition of the attractive powers of the particles of bodies? Are heat and light elements of electricity, or mere effects of its action? Is magnetism identical with electricity, or an independent agent, put into motion or activity by electricity? Though these abstruse and difficult questions exceed our present means of solution, it appeared to Sir Humphry an object of considerable moment, and intimately connected with them, to determine the relations of electricity to space as nearly void of matter as it can be made upon the surface of the earth; his experiments on these subjects are detailed in this paper.

The most perfect mercurial vacuum that could be procured was permeable to, and rendered luminous by, electricity; when the tube was very hot the light was green and dense; as the temperature diminished it became less vivid, and at -20° was scarcely perceptible, except in a very dark place. The ingress of very small portions of air rendered the light blue and purple, and increased the conducting power of the medium. In a vacuum above fused tin, the phenomena were nearly the same.

From the general results of these experiments, it is inferred that the light (and probably the heat,) generated in electrical discharges, depends principally upon some properties or substances belonging to the ponderable matter through which it passes; but they prove likewise that space, where there is no appreciable quantity of this matter, is capable of exhibiting electrical phenomena; and, under this point of view, they are favourable to the idea of the phenomena of electricity being produced by highly subtile fluid or fluids, of which the particles are repulsive, with respect to each other, and attractive of the particles of other matter. On such an abstruse question, however, there can be no demonstrative evidence.

This paper contains many valuable hints respecting the existence of air in mercury, and the best means of obtaining a vacuum free from it, which seem of considerable importance in their relation to the construction of barometers.

9. *Croonian Lecture. On the Anatomical Structure of the Eye, illustrated by Microscopical Drawings, executed by* F. Bauer, Esq. *By* Sir E. Home, Bart., V.P.R.S.

The author first states, that he got Mr. Bauer to ascertain the structure of the marsupium by examination in the microscope, to determine how far it was muscular, and it proved to be, as Dr. Young long ago considered it, wholly membranous.

He then had the different parts of the eye examined in the same way, and gives a description of their structure in the human eye, and in that of the quadruped, and of the bird. The ciliary processes are in the human eye about eighty in number, lying directly behind the iris; these are membranous, and very vascular. In the interstices between these processes are bundles of muscular fibres, $\frac{25}{100}$ of an inch in length, which have never before been described; they pass from the capsule of the vitreous humour to the capsule of the lens; anteriorly, they are unconnected with the ciliary processes, or iris. In the choroid coat lymphatic vessels are shewn in the drawings, never before met with. The disease of a living worm met with in India in the aqueous humour of the horse's eye, is explained by these worms being found in the blood of the horse, and the vessels in the ciliary processes being large enough to drop them into the anterior chamber of the eye. The fibres of the lens have the appearance of hairs, like those formed in spun glass.

The situation of the marsupium in the bird's eye, is shewn in the drawings, both in the eagle and the goose, and the difference of curvature at the bottom of the eye on its two sides is endeavoured to be represented as accurately as such subjects admit of; by the nicest measurement, that side next the beak was $\frac{8}{40}$ of an inch, the other side $\frac{7}{10}$th.

Six plates accompany this paper, admirably executed by Mr. Basire, from the accurate drawings of that unrivalled draughtsman, Mr. Bauer.

10. *A Letter from* John Pond, Esq., Astronomer Royal, *to* Sir Humphry Davy, Bart., P.R.S., *relating to a derangement in the Mural Circle, at the Royal Observatory.*

This letter is dated "November, 1821," and as the amount of the error, and the correction which should be applied to the observations made within the two preceding years, have been already stated by the Astronomer Royal, in the Preface to the Greenwich Observations for 1820, it is not necessary to enter into the history of the derangement of the mural circle, which Mr. Troughton has long ago rectified.

11. *On the Finite Extent of the Atmosphere. By* William Hyde Wollaston, M.D., V.P.R.S.

After adverting to the hypothesis of the limited divisibility of our atmosphere, and to that of its unlimited expansion, Dr. Wollaston observes, that, in the former case, it may be presumed to be peculiar to our planet, but, in the latter, to pervade all space, where it would not be in equilibrio, unless the sun, moon, and planets possessed their respective shares of it, condensed around them in degrees dependent upon the force of their respective attractions, except where other kinds of matter or unknown powers may be supposed to interfere. He then remarks, that though we have not the means of ascertaining the extent of our own atmosphere, those of other planets are nevertheless objects for astronomical investigation, and that it deserves consideration whether, in any instance, a deficiency of such matter can be proved; and whether, from this source, any conclusive argument can be drawn in favour of ultimate atoms of matter in general. From observations of the passage of Venus near the Sun, in superior conjunction in May, 1821, made by Dr. Wollaston and Captain Kater, for three days and a half before and after the conjunction, no retardation of the passage of the planet, such as would occur from increasing refraction, could be perceived, and in consequence no evidence obtained of the existence of a solar atmosphere. Dr. Wollaston then mentions the occultation of Jupiter's satellites by the body of the planet, the approach of which, instead of being retarded by refraction, is regular, till they appear in actual contact; here, therefore, it is evident there is not that extent of atmosphere which Jupiter should attract to himself from an infinitely divisible medium filling space; the universal prevalence, therefore, of such a medium cannot be maintained. On the contrary, all the phenomena accord with the supposition, "that the earth's atmosphere is of finite extent, limited by the weight of ultimate atoms of definite magnitude, no longer divisible by repulsion of their parts."

12. *On the Expansion in a Series of the Attraction of a Spheroid.* *By* James Ivory, M.A., F.R.S.

Mr. Ivory's principal object in this paper appears to be the removal of some difficulties which occur in the demonstration of the method of developing the attractions of spheroids in an infinite series, as employed by Laplace in the *Mécanique Céleste.* "It is natural to think," he observes, "that the theory of the figure of the planets would be placed on a firmer basis, if it were deduced directly from the general principles of the case, than when it is made to depend on a nice and somewhat uncertain point of analysis;" and he conjectures, "that the theory will probably be found to hinge on this proposition: that a spheroid, whether homogeneous or heterogeneous, cannot be in equilibrium by means of a rotatory motion about an axis, and the joint effect of the attraction of its own particles and of the other bodies of the system, unless its radius be a function of three rectangular co-ordinates;" for "if this proposition," he continues, "were clearly and rigorously demonstrated, the analysis of Laplace, in changing the ground on which it is built, would require little or no alteration in other respects."

Without, however, attempting to demonstrate this proposition in all its extent, the author has substituted a mode of argument more direct and more simple than that of Laplace, which is perfectly conclusive with respect to all the cases to which the theorem in question can possibly require to be applied. He has shown that by immediately transforming a given expression into a function of three rectangular co-ordinates, we obtain the same developement as is deduced in the *Mécanique Céleste* by a more general and complicated mode of reasoning, which seems to be so far objectionable, as it tends to introduce a variety of quantities into the series, which do not alter its total value, since they destroy each other, but which may possibly interfere with the accuracy of its application to particular cases, in which it may be employed as a symbolical representation; for example, when any finite number of terms is assumed as affording an approximate value: since if the expression developed has not been reduced to the form of a function of three rectangular co-ordinates, the developement may contain an infinite number of terms which are introduced by the operation, without being essential to its final result.

He takes for an example of such a case the equation of a spheroid prominent between the equator and the poles, somewhat resembling the figure which was once attributed to Saturn: and he shows that its developement in the form required will contain an infinite number of quantities, arising from the expansion of a radical, which are not to be found in the original function.

Mr. Ivory considers in the second place the differential equation that takes place at the surface of a spheroid, and the demonstrations which have been published by Laplace and by Poisson; and he concludes that this equation "is wanted neither for proving the possibility of the developement, nor for calculating its terms. But in this plainer way of considering the matter," he proceeds, "it appears that the developement does not represent the given expression when that expression is *not* an explicit function of three rectangular co-ordinates, in the same sense that it does, when it *is* such a function. There is therefore a difficulty left unexplained; and we may be permitted to doubt, whether so important a part of the celestial mechanics, as that regarding the figure of the planets, rests with sufficient evidence on the doctrine laid down concerning the generality of the developement."

13. *On the late extraordinary Depression of the Barometer. By* Luke Howard, Esq., F.R.S.

The object of this short paper is to record the remarkable fall of the barometer in December, 1821. On the evening of the 24th of that month, Mr. Howard's barometer at Tottenham fell to 28.20 inches, the wind being moderate at south-east, with steady rain, and the thermometer in the open air standing at eight in the evening at 45°. At five o'clock on the morning of the 25th the barometer fell to 27.83 inches; at eight o'clock it rose to 28 inches, and at eight in the evening to 28.40. In the early morning of the 27th, not having yet reached 29 in., it turned to fall again, with the wind at S. and S.W., after S.E.: we had again some heavy rain with hail about noon, and by midnight the quicksilver reached 28.0[illegible], or .06 in., where it stood, or rather made minute oscillations, *during the 12 hours following*, a thing I should scarcely have thought possible in our climate.

At noon on the 29th the barometer began to ascend, and on the 31st it reached 30 inches.

The rain for the two months of November and December, 1821, amounted to 10.10 inches, a quantity without any recorded precedent in the same space of time in London.

A more experienced and skilful meteorologist than Mr. Howard we do not know; his work on the climate of London testifies his persevering industry and accurate observation; the conclusion of his paper therefore we take the liberty of transcribing, as a lesson to all prognosticators of the weather. I am almost at a loss for an apology to the Society, for having in my last paper anticipated, on the strength of a single analogy, a *dry* year for 1821, the fact being, that there has fallen at Tottenham, in the whole year, no less than 33.81 inches. It seems as if, with all our anxiety to pass the stream of uncertainty in this science, we must give over making the wooden bridges of conjecture, and wait till we can accumulate more solid materials.

14. *On the anomalous Magnetic Action of Hot Iron between the White and Blood-red Heat. By* Peter Barlow, Esq., *of the Royal Military Academy.* Communicated by Major Thomas Colby, of the Royal Engineers, F.R.S.

In conducting some experiments upon the influence of high temperatures upon the magnetism of different kinds of iron and steel, Mr. Barlow observed the following very singular circumstance.

Between the white heat of the metal, when all magnetic action was lost, and the blood-red heat, at which it was the strongest, there was an intermediate state in which the iron attracted the needle the contrary way to what it did when it was cold, viz., if the bar and compass were so situated that the *north* end of the needle was drawn towards it when cold, the *south* end was attracted during the interval above alluded to, or while the iron was passing through the shades of colour denoted by the workmen the bright red and red heat.

The author enters into a detail of his experiments connected with, and in illustration of, this anomalous action; and observes, that the only probable explanation of it which he can offer is,

that the iron cooling faster towards its extremities than towards its centre, a part of the bar will become magnetic before the other part, and thereby cause a different species of attraction; but I must acknowledge, that this will not satisfactorily explain all the observed phenomena. The results, however, are stated precisely as they were noted during the experiments, and others more competent than myself will probably be able to deduce the theory of them.

15. *Observations for ascertaining the Length of the Pendulum (vibrating seconds) at Madras in the East Indies, with the Conclusions drawn from the same. By* John Goldingham, Esq., F.R.S.

The observations, the results of which are detailed in this paper, were made upon the same plan, and with a similar apparatus to those formerly published in the *Philosophical Transactions* by Captain Kater. The mean length of the pendulum vibrating seconds, thus established at Madras, in latitude 13° 4′ 9″.1 north, at the level of the sea in vacuo, and at a temperature of 70° of Farenheit, is 39.026302 inches of Sir George Shuckburgh's scale.

16. *Account of an assemblage of Fossil Teeth and Bones of Elephant, Rhinoceros, Hippopotamus, Bear, Tiger, and Hyæna, and sixteen other animals; discovered in a cave at Kirkdale, Yorkshire, in the year* 1821: *with a comparative view of five similar caverns in various parts of England, and others on the Continent. By the* Rev. William Buckland, F.R.S., F.L.S., *Vice President of the Geological Society of London, and Professor of Mineralogy and Geology in the University of Oxford, &c. &c. &c.*

In this long but entertaining paper, Mr. Buckland gives an account of the geological position and relations of the rock in

which the cavern mentioned in the title is situated; he then describes the cavern itself, enumerates in detail the animal remains which were found in it, describes the phenomena with which they were attended, suggests the conclusions to which these phenomena lead, and concludes with a comparative account of analogous animal deposits in other parts of this country and the continent.

The cave is in a [illegible] bed of oolitic limestone; it is coated with stalactite and floored with mud and stalagmite, in which the bones are found, and to which they appear to owe their preservation. The following are the animals whose bones it is stated to have been recognised. Hyæna, tiger, bear, wolf, fox, weasel, unknown wolf-like animal, elephant, rhinoceros, hippopotamus, horse, ox, three species of deer, rabbit, water-rat, mouse, raven, pigeon, lark, duck. These bones are almost all broken and imperfect, and many of them gnawed; hence the author assumes that the cave was originally inhabited as a den by hyænas, and that they dragged into its recesses the other animals whose remains are found mixed indiscriminately with their own, and as hyænas do not scruple upon an emergency to eat each other, no wonder that their own bones are intermixed with those of other animals; the ruminants, however, seem to have formed their ordinary prey, and as very few of [illegible] found in the cave bear marks of age, it is probable that they perished by a violent death.

[illegible] of water rats has also been alluded to; [illegible] rats may appear ridiculous, it is consistent with the [illegible] appetite of modern hyænas; nor is the [illegible] the [illegible] of its prey, greater than that [illegible] which are supposed by Captain Parry to feed chiefly on mice during the long winter at Melville Island. Our largest dogs eat rats and mice; jackals occasionally prey on mice, and dogs and foxes will eat frogs. It is probable, therefore, that neither the size nor aquatic habit of the water rat would secure it from the hyænas. They might occasionally also have eaten mice, weasels, rabbits, foxes, wolves, and birds; and in masticating the bodies of these small animals with their coarse conical teeth, many bones and fragments of bone would be pressed outwards through their lips, and fall neglected to the ground.

As the cave was too small for the entrance of elephants, rhinoceri, and hippopotami, Mr. Buckland ingeniously supposes that they died a natural death in the neighbourhood, and that their limbs were conveyed piecemeal into the den by its omnivorous inhabitants.

Should it be asked why, amidst the remains of so many hundred animals, not a single skeleton of any kind has been found entire, we see an obvious answer, in the power and known habit of hyænas to devour the bones of their prey; and the gnawed fragments on the one hand, and *album græcum* on the other, afford double evidence of their having largely gratified this natural propensity; the exception of the teeth and numerous small bones of the lower joints and extremities, that remain unbroken, as having been too hard and solid to afford inducement for mastication, is entirely consistent with this solution. And should it be further asked, why we do not find,

at least, the entire skeleton of the one or more hyænas that died last, and left no survivors to devour them, we find a sufficient reply to this question, in the circumstance of the probable destruction of the last individuals by the diluvian waters: on the rise of these, had there been any hyænas in the den, they would have rushed out, and fled for safety to the hills; and if absent, they could by no possibility have returned to it from the higher levels: that they did so perish on the continent is obvious, from the discovery of their bones in the diluvial gravel of Germany, as well as in the caves. The same circumstance will also explain the reason why there are no bones found on the outside of the Kirkdale cave, as described by Busbequius on the outside of the hyænas' dens in Anatolia; for every thing that lay without, on the antediluvian surface, must have been swept far away, and scattered by the violence of the diluvian waters; and there is no reason for believing that hyænas, or any other animals whatever, have occupied the den at any period subsequent to that catastrophe.

It seems evident from the contents of this cave, that the country was once inhabited by animals no longer known in this climate; the author thinks that at the period of the deluge the mud was introduced, and the inhabitants destroyed; and lastly, that this mud was incrusted by calcareous matter, since which no animal of magnitude entered the cave till it was opened in the summer of 1821.

Mr. Buckland's paper is illustrated by a map and numerous engravings, showing the appearance of the teeth and bones; of these, we may add, a good collection has been presented to the Royal Institution by W. Salmond, Esq., of York, who has very successfully interested himself in the examination of this truly singular assemblage.

17. *Communication of a curious appearance lately observed upon the Moon. By the* Rev. Fearon Fallows. *In a Letter addressed to* John Barrow, Esq., F.R.S.

This letter is dated " Cape Town, Cape of Good Hope, Dec. 13, 1821." It describes a white spot on the dark part of the moon's limb, then and there seen by Mr. Fallows.

18. *On the difference in the appearance of the teeth and the shape of the skull in different species of Seals. By* Sir E. Home, Bart., V.P.R.S.

This is a description of three skulls of seals, which are shown to differ from each other in three annexed engravings.

IV. *Treatise on Meteorology*, by John Leslie, Esq., Professor of Natural Philosophy in the University of Edinburgh, and corresponding Member of the Royal Institute of France*.

Were the progress of any science proportionate to the number and anxious zeal of its cultivators, that of meteorology should

* Published in the supplement to the fourth and fifth editions of the Encyclopedia Britannica, vol. v., part 2d.

be eminently advanced. Every man, and especially every Englishman, is more or less a meteorologist; often hazarding his property, comfort, and health, in his fancied proficiency. The morning salutation of friends has usually a reference to the weather, and is, in this island, generally followed by remarks on atmospheric phenomena. The aspect of the sky is a never-failing topic of common-place conversation, and the evening farewell to society is frequently coupled with meteorological conjectures. Yet, notwithstanding all this interest, attention, and observation of citizens, agriculturists, and sailors, joined to the speculations of the learned, meteorology cannot yet lay claim to the title of a science. Its phenomena are for the most part incoherent and anomalous; baffling very often the indications of art, as well as the sagacity of experience; and its general facts are scanty in the extreme, or liable to numerous exceptions. Its very imperfection, however, gives a salutary lesson, as it shews us in the clearest light, the inadequacy of the human faculties unaided by instruments of measurement and research, to explore the secret laws of nature. How instructive, in this respect, is the comparison of our knowledge of the heavenly bodies, with that of the atmosphere! The graduated quadrant and sphere soon enabled mankind to form some tolerably correct notions of the celestial movements; nor can we, at the present day, think of the astronomical attainments of Hipparchus, and the masters of the Alexandrian school, without admiration. While the heavens have in these latter days, been unveiled in all the magnificence of their mechanism, rendering astronomy at once the lofty monument and hallowed sanctuary of human reason, the atmosphere continues a mere object of vague remark. It is but lately indeed that its phenomena have been at all subjected to instrumental examination. Torricelli and Sanctorio furnished the first means of measuring the variations of its pressure and temperature; circumstances now rigorously determined by the barometers and thermometers of modern artists. Its electrical changes, so brilliant, but often so appalling to the common mind, were happily explored by the intrepid sagacity of Franklin, who traced out to succeeding electricians an interesting line of research, which however has been but sparingly pursued.

For the first accurate principles on which its condition as to moisture might be estimated, we are indebted to M. Le Roi, of Montpellier. He exposed a glass vessel containing cold water to the open air, and noted the highest point of temperature, at which the vessel possessed the power of condensing atmospheric dew, on its sides. The nearer this point approached to the temperature of the atmosphere, the nearer the air approached to a state of aqueous saturation. Mr. Dalton has since rendered this simple fact subservient to the more refined purpose of mea-

suring both the elasticity and weight of the humidity in the atmosphere, by his ingenious experiments on the force of vapours, and his theorem of their mixture with gases. Mr. Daniell has, finally, given the principle of Le Roi, and the tables of Dalton, the utmost precision, facility, and generality of application, by the invention of his hygrometer*.

Dr. Black's researches on the absorption of heat during the evaporation of liquids, suggested to Saussure and Hutton, another hygrometric measure, viz., the depression of a thermometer having its bulb moistened and exposed to a current of air. This method furnishes a convenient hygroscope, which Professor Leslie has modified by using an air thermometer on Van Helmont's construction, instead of one with mercury or alkohol. Of this change, however, we cannot perceive the advantage; for two sensible mercurial thermometers, with one of the bulbs wrapped in dry and the other in moist muslin, both supported in one frame, will not only give results of sufficient delicacy, but are at the same time expressed in a language far less arbitrary than that of his scale. Common thermometers have also the advantage of perfect portability and are still applicable to any other purpose, while Mr. Leslie's hygroscope is easily deranged by carriage, and is at any rate fit for nothing else.

The principle of Le Roi, as developed by Dalton, and applied by Daniell, is further capable of determining the evaporating force in the atmosphere; or of shewing the quantity of moisture which can rise from a given surface, in vapour, in a certain time. The same thing has been attempted in many ways; most of them, however, more or less complicated with the radiating power as to caloric, possessed by the body which contains the water. Thus if water be exposed in a clear day to the atmosphere in two shallow capsules, one of glass, and the other of silver, but both of the same size and shape, it will become colder in the glass, than in the metallic vessel, and will therefore evaporate more slowly in the former than in the latter.

The writer of the curious treatise before us, is well known to have devoted a great deal of study to the *relation of heat and moisture*, the title indeed of a small tract published by him some years ago. Like that disquisition, the one now before us is remarkable for the prominence given to the description and praise of the author's own contrivances, which are after all merely the varied aspects of Dr. Black's proposition with regard to the absorption of caloric. But Mr. Leslie scarcely deigns to allude to any of his philosophical contemporaries to whom meteorology is primarily indebted; nor do we find the slightest

* Journal of Science and the Arts, viii. 298.

mention of the labours of Dalton, Gay-Lussac, Biot, Daniell, and several others, who have written most ably and ingeniously on hygrometric phenomena.

But if our author be somewhat chary in his account of the researches of his rivals in scientific fame, he has been abundantly profuse of his own lucubrations, a few of which seem both ingenious and plausible, but others are so fantastic and extravagant, as to make us wonder how a gentleman of Mr. Leslie's attainments could wantonly bring his philosophical reputation into jeopardy by their serious enunciation.

After exposing the fallacy of the meteorological cycles, hitherto offered, Mr. Leslie proposes to establish meteorology on a solid basis, by *first* inquiring into the extent and constitution of the medium which we breathe; and *next* reviewing

the different philosophical instruments which assist external observation, and indicate at all times the exact condition and qualities of that mutable fluid.

The following mode of proving that the elevation of the atmosphere above the surface of our globe can never exceed a certain absolute limit, seems ingenious.

The highest portions of the atmosphere, which is carried round in twenty three hours, and fifty-six minutes, by the rotation of the earth about its axis, would be projected into space, if their centrifugal force at that distance. were not less than their gravitation towards the centre. But the centrifugal force is directly as the distance, while the power of gravity is as its square. Consequently, when the centrifugal force at the distance of 6.6 radii of the earth is augmented as many times, the corresponding gravitation is diminished by its square, or 43.7 times, their relative proportion being thus changed to 289. Now the centrifugal force being only the 289 part of gravity at the surface of the equator, it will therefore just balance this power at the distance of 6.6 radii from the centre, or at the elevation of 22,000 miles *.

It is equally curious and satisfactory that Dr. Wollaston, in his elegant memoir on the finite extent of the atmosphere, by a totally distinct train of investigation and research has come to nearly the same conclusion. "But if air consist of any ultimate particles no longer divisible, then must expansion of the medium composed of them cease at that distance where the force of gravity downwards upon a single particle is equal to the resistance arising from the repulsive force of the medium †". And again, "All the phenomena accord entirely with the supposition that the earth's atmosphere is of finite extent, limited by the weight of ultimate atoms of definite magnitude, no longer divisible by repulsion of their parts ‡." Mr. Leslie, however, somewhat inconsistently draws another inference from his calculations, which Dr. Wollaston's researches will not suffer us to admit: "Perhaps the fluid itself," says the Professor, " may

* Page 325. † Phil. Trans. for 1822, part 1st. p. 90. ‡ Ibid. p. 98.

change in these lofty regions, and pass into a sort of ethereal essence, more analogous to diffuse light than to a mass of air." Or in other words, perhaps the air ceases to be air, and then its elevation can exceed a certain limit, contrary to his own proposition.

In treating of the *constitution* of the atmosphere, he says, it may be doubted whether the chemical analysis be complete, adding, "The combination of these gases (oxygen, azote, and carbonic acid,) obtained artificially, generates a fluid, in which we can hardly recognise the ordinary qualities of atmospheric air. Some fugacious elements must therefore escape, during the process of decomposition." We know not on what chemical authority Mr. Leslie makes this assertion, nor are we aware of any chemist having shewn that pure azote, oxygen, and carbonic acid, in due proportions, form a mixture, "in which we can hardly recognise the ordinary qualities of atmospheric air." On the contrary, this mixture certainly possesses all the ordinary relations to animal life, combustion, and humidity, which native air does.

The following speculations appear altogether fanciful:—

But a variety of circumstances render it extremely probable, that an expanse far above the region of the clouds, is filled by some peculiar fluid, very different from the grosser element spread below. The shooting stars, which are seen every clear night, the *bolades*, or fire-balls, and the luminous arches which not unfrequently occur, and which must traverse the sky at the height of several hundred miles, all seem to indicate the existence of a very ignitible medium. Nor is it difficult to conceive how such a collection of highly inflammable fluids could be formed. Not to mention the multiplied processes of art which emit those products, the great laboratory of nature is incessantly at work in generating and pouring forth hydrogen gas, and its various compounds. The volcanic mountains over a considerable portion of the surface of the globe, and their innumerable spiracles, with scarcely any interruption, continue to discharge immense streams of inflammable aerial fluids, a great part of which escape conflagration. But as hydrogen gas has little attraction to common air, it rises upwards by its buoyancy, without suffering much loss in its passage through that fluid. The largeness of their volume, and the celerity of their projection, conspire to favour the ascent of those inflammable gases to the loftiest regions of the atmosphere. A comparison of the several quantities of astronomical refraction at different altitudes, points to a similar conclusion. The refraction which the rays of light suffer in slanting across the higher regions of the air, is greater than what calculation assigns to the corresponding density of the medium. But the discrepancy would entirely disappear, if we suppose these strata to consist of hydrogen gas, which is known to possess, in a remarkable degree, the power of refracting*.

Mr. Leslie forgets that a collection of highly inflammable fluids cannot be inflamed, unless in intimate contact with some different kind of fluid, with which they may combine. As to the argument from astronomical refraction, we shall not put

* P. 326.

much stress upon it, if we recollect the progressive diminution of temperature which takes place in the higher regions of the atmosphere, whence its density will be greater than the mere logarithmic formula indicates.

Mr. Leslie's next speculation is far more visionary than the above (which is by no means new), and seems strangely misplaced in a Dictionary of the Sciences.

Having ventured to state that the highest region of the atmosphere is probably occupied by some very diffuse phosphorescent gas, we shall hazard a conjecture which will appear bolder, and even paradoxical; that perhaps air, in its most concentrated state occupies the bottom of the ocean, and forms a vast bed, over which the incumbent waters roll. Air has actually been condensed above a hundred times, and during this process it betrayed no deviation from the fundamental law, that its elasticity is directly proportional to its density. There seems no reason, therefore, to doubt, that if an adequate compressive force could be exerted, air might be reduced to the thousandth part of its original volume. But this elastic fluid would then be denser than the water, and consequently instead of rising, would fall through the liquid. Suppose, for instance, a bladder filled with air, and having a small bullet attached to it, were thrown into the sea; in continuing to sink, it would reach a depth where the enormous weight of the column of water would compress it to the same density as the surrounding mass; and if the bullet were now disengaged, the bladder would remain suspended in that stratum, or if carried a little lower, it would precipitate itself to the bottom.

He then enters into a tedious calculation to show that at the depth of 28.885 feet, there would be an equilibrium between the condensed air, and the corresponding stratum of sea water. This computation (adds he) is to be considered as only a near approximation, yet sufficiently accurate for the object in view. Nor shall we fatigue our readers by the investigation of a strict formula, including exponentials. It is enough to mark the conclusion, that any portion of air carried five and a half miles below the surface of the sea will never ascend again. Now this limit is only half the depth, which, the theory of tides assigns to the waters of the ocean. There is more difficulty in conceiving by what process air can be conveyed to its abyss. Increase of pressure, however, enables water to hold a larger share of air; and the effect is hence the same as an augmented attraction. The minute globules of air, may therefore be gradually drawn downwards from stratum to stratum, till they are at last detached from the body of water by their own superior density. The precipitation and accumulation of concentrated air under the ocean, would thus be the result of some unceasing operation. Such a process may, perhaps, constitute a part of the great economy of Nature. It seems probable, that the existence of a subaqueous bed of air is necessary to feed the numerous fires which occasionally rage in the bowels of the earth, and occasionally burst forth on the surface in volcanic spiracles*.

We think this the wildest conceit that has ever figured in a sober work on philosophy. It throws Bishop Wilkins' schemes quite into the shade; and seems to rival some of Mr. Southey's oriental fictions, from one of which, the Domdaniel cavern, it is manifestly borrowed. We shall not consume our reader's time with

* P. 326.

a serious refutation of this shower of atmospheric air-drops, pushing themselves down the watery abyss from five and a half miles beneath the surface to the very bottom. Nor shall we alarm their fears, for the respiration of posterity, when this "*unceasing operation*" shall have smuggled the whole atmosphere into its submarine vaults. We shall merely congratulate old Ocean on the possession of this soft, elastic, and self-adjusting pillow. To complete this new Neptunian theory, Mr. Leslie should have shewn how when this pillow becomes over-stuffed, the surplus air could be squeezed out, as occasion required, through one of Pluto's spiracles, to inflate the bellows of the "Cyclops."

Having *thus* settled, in preliminary research, the constitution of the atmosphere, the Professor next enters on his account of meteorological instruments. The ordinary observations (says he) are confined to the weight and temperature of the air. There are other *data* still wanted, to determine at any time, the actual condition of that medium. The dryness or humidity of the atmosphere, its brightness or degree of illumination, the different depth of the cœrulean hue of the sky, and the variable disposition to chill the surface of the earth by impressions of cold transmitted from the higher regions,—these objects of inquiry should be conjoined with others of a more practical tendency, depending immediately on the mutable state of the weather. Such are the attempts to measure the daily evaporation from the ground, to register the quantity of rain which falls, and to mark the direction and indicate the force or velocity of wind. A complete apparatus of meteorological instruments will therefore include primarily the *barometer, thermometer, hygrometer, photometer, æthrioscope, cyanometer*; and comprehend likewise the *atmometer, rain-gauge, drosometer*, and *anemometer*. We shall review this series in the order of enumeration*.

In treating of the influence of dryness and moisture on the barometrical altitude, he says, "but even supposing a column of air to become suddenly charged with humidity, before its subsequent dilatation had, by diffusing it produced an equilibrium, still the additional pressure would have been extremely small, not exceeding at a moderate computation the *fifteenth* part of a mercurial inch†." If Mr. Leslie will consult Mr. Daniell's elaborate tables, inserted in the eighth volume of this Journal, he will find, that the pressure of the vapour in the atmosphere, amounts occasionally to 6-10ths of a mercurial inch, or 9-15ths, and during the month of September, as there recorded, it was on an average, more than 5-10ths, though it was seldom thoroughly *charged with moisture*, to use the Professor's term.

Most of our readers are probably acquainted with Mr. Hawksbee's ingenious experiment to illustrate the influence of wind in depressing the mercury in the barometer. Having connected the cisterns of two barometers with a horizontal tube, he then transmitted across the mercury in the basin of the one, a rapid current of air from a globe into which it had been previously injected to three or four times its usual density. The mercurial

* P. 327. † *Ibid.*, col. 2

column immediately fell about two inches in both tubes. Professor Leslie objects to Mr. Hawksbee's inference from this experiment, because the outlet tube seems to have been wider, than that by which the air was admitted. But this is exactly the condition of the atmosphere in high winds. At the place where the equilibrium is disturbed (whether by rarefaction of the air, as most people think, or by its precipitation into the ocean abyss, with Mr. Leslie) the motion will be quickest; and it will progressively slacken in the more distant masses of air, from their increasing inertia, friction, &c. Hence, therefore, to represent this phenomenon by experiment, we must allow the air ample room to expand itself as it advances in the tube. We have, however, no objection whatever to the Professor's theory of the variation of the barometer, in supplement to the commonly received effect of wind. 'It is obvious, says he, that a horizontal current of air, must from the globular form of the earth, continually deflect from its rectilineal course. But such a deflection being precisely of the same nature as a centrifugal force, must hence diminish the weight or pressure of the fluid. The only question is to examine the amount of that disturbing influence. Though it should appear quite inconsiderable in the interval of a short space, it may yet accumulate to a very notable quantity through the wide extent over which the same wind is known to travel..... In the space of 288 miles, this diminution (of atmospheric pressure) would consequently be the 300th part of the incumbent weight, that is, 1-10th of an inch, when the wind is flowing at the rate of one mile per minute, nearly a seaman's gale. Surely this result is so inconsiderable, as to indicate that some more direct operation of wind must produce the depression of the mercurial columns.

Mr. Leslie refers to the same principles of deflection of the horizontal current, the phenomena of eddies, whirlwinds, and tornadoes. But we confess that his reasoning here appears to us loose and gratuitous. Why not call up some of the condensed air "from the vasty deep?" a task full as easy as getting it down; and the whirling rapidity of its escape, would, at the same time, have accounted for the *jet d'eau* and vortex of a water-spout.

Under the second section, entitled *thermometer*, we are presented with a verbose and rather common-place account of this useful instrument, to which is attached in a note, a long formula for computing in general the size of the scale of the differential thermometer. We shall give a specimen of this over refinement on a subject, with which no person, we believe, will ever perplex himself. Let the diameters of the two balls be expressed in inches by a and b, the diameter of the bore of the tube being denoted by d, and the measure of a centesimal degree by x....By reduction

$$x = \frac{22\, a^3 b^3}{8250\,(d^2 a^3 + d^2 b^3) + 25 a^3 b^3}$$

We should like to know how the interior diameter of the balls is to be found with a precision adapted to this formula teeming with cubes and squares. Every practical man must regard this equation as mere mockery.

Section 3d relates to the *Hygrometer*, in which, after some of the usual remarks on the various bodies, animal, vegetable, and mineral, called hygroscopes, because absorbent of moisture from the atmosphere, Mr. Leslie proceeds to describe his own hygrometric contrivances; the account of these is spread over about twenty columns of typography, besides two pages of table. The first instrument is his ivory hygroscope, consisting of a thermometer-formed vessel, filled with mercury, in which the descent and ascent of this liquid is determined by the swelling and shrinking of the ivory bulb, with the variations of its moisture and dryness. The tardiness of the indications of such an instrument, disqualifies it, even in Mr. Leslie's eyes, for every sort of delicate observation.

We agree with our author in thinking that philosophers entertained, till very lately, crude notions respecting the association of moisture with air; and of the different circumstances which regulate or influence the process of evaporation. But we are greatly surprised at the silence observed with regard to Mr. Dalton, to whom we are indebted for exposing those crude notions, and establishing a correct theory on this important subject; the more so, as Mr. Dalton's merit is universally recognised by all those French writers, with whose works Mr. Leslie appears perfectly conversant. The following statement seems unaccountable in a British author: But experiments on the influence which an increase of temperature exerts on the quantity of evaporation, have been prosecuted with various success by Lampadius, Saussure, and Kirwan. The results thus obtained, unfortunately differ very widely; and though the researches of the celebrated naturalist of Geneva were those conducted with the most care and address, yet they seem, from the vagueness of their elements, not entitled to much confidence*. Here we have not one word of Mr. Dalton's decisive investigations, published long ago in the *Manchester Memoirs*, and thence transferred into almost every elementary book.

The Professor next presents us, at great length, we would say superfluous prolixity, with his analysis of the operation by which cold is produced by evaporation, on which is founded the action of his own hygroscope. We have no desire to transcribe any part of this tedious developement, especially as we are satisfied that his instrument is far inferior to the simple process of Le Roy or Dalton, and still more so to the refined contrivance of Mr. Daniell. Mr. Leslie even adopts the exploded notion of a gas holding its hygrometric water by a peculiar solvent power.

The energy of hydrogen gas (says he) is therefore scarcely less remarkable in dissolving moisture, than in containing heat. Confined with a powerful absorbent substance, while common air marks eighty degrees of dryness, hydrogen gas will indicate seventy. This gas must in similar circumstances, therefore, hold in solution seven times as much moisture as the atmospheric medium †. And the marginal title of his next paragraph

* P. 337. † P. 341.

is "Law of Atmospheric Solution." We need only say in reply to this strange doctrine, that his indicator must be grievously fallacious, since it has been determined by the concurring experiments of every modern chemist, who has ever treated the subject, that equal bulks of dry hydrogen gas, and of common air, confined over water, at the same temperature, become associated with exactly the same weight or volume of aqueous vapour; or one of the former, by *weight*, acquires as much as 14.4 of the latter.

The following passage exhibits, we conceive, a singular perversion of philosophical research. We shall give it without comment. To discover the precise law, by which equal additions of heat augment the dryness of air, or its power to retain moisture, is a problem of great delicacy and importance. Two different modes were employed in that investigation, but which led to the same results. The one was, in a large close room, to bring a hygrometer conjoined with a thermometer, successively near to a stove intensely heated, and to note the simultaneous indications of both instruments, or to employ two nice thermometers, placed beside each other, and having their bulbs covered respectively with dry and with wet cambric. By taking the mean of many observations, and interpolating the intermediate quantities, the law of *aqueous solution in air* was laboriously traced. But the other method of investigation appeared better adapted for the higher temperatures. A thin hollow ball of tin, four inches in diameter, and having a very small neck, was neatly covered with linen; and being filled with water nearly boiling, and a thermometer inserted, it was hung likewise in a spacious close room, and the rate of its cooling carefully marked. The experiment was next repeated by suspending it to the end of a fine beam, and wetting with a hair pencil the surface of the linen, till brought in exact equipoise to some given weight in the opposite scale; ten grains being now taken out the humid ball was allowed to rest against the point of a tapered glass tube, and the interval of time with the corresponding diminution of temperature, observed, when it rose again to the position of equilibrium. The same operation was successively renewed; but as the rapidity of evaporation declined, five, and afterwards two, grains only were, at each trial, withdrawn from the scale. From such a series of facts, it was easy to estimate the quantities of moisture *which the same air will dissolve at different temperatures*, and also the corresponding measures of heat expended in the process of solution *.

As if the above were not enough to mystify what Mr. Dalton and M. Gay-Lussac, and others, have long ago made sufficiently clear, he next presents us with a small table of the *solvent power of air*, from the temperature of fifteen centigrade degrees below zero, to forty-four above it; or from 5° Fahr. to 112.2°!

We have now, we believe, adduced sufficient evidence, that this long section on the *hygrometer* is equally erroneous in philosophical principle, as it is deficient in practical utility. Such of our readers as wish to acquire correct information on this matter, may consult with advantage Mr. Dalton's various memoirs already alluded to, Mr. Daniell's papers in this Journal, and M. Biot's chapter in the first part of his *Traité de Physique*, on the relation between air and moisture.

* Pp. 341 and 342.

Mr. Leslie's fourth section (misprinted fifth) is entitled *The Atmometer*. "The atmometer consists of a thin ball of porous earthenware, two or three inches in diameter, with a small neck, to which is firmly cemented a long and rather wide glass tube, bearing divisions, each of them corresponding to an internal annular section, equal to a *film of liquid* that would cover the outer surface of the ball, to the *thickness of the thousandth part of an inch.*" "It does not mark the mere dryness of the air, but it measures the quantity of moisture exhaled from a humid surface in a given time*." We believe that very few persons ever employed this instrument, the functions of which are far better performed by suspending, at the end of a balance, a vessel of porous earthenware, containing water. Knowing the surface, temperature, and loss of weight, the problem of evaporation is soon resolved. A thermometer may have its ball inserted in the water, its stem passing through a common cork in its mouth.

The *photometer*, or instrument which measures the degree of light, is a differential thermometer, having one of its balls diaphanous, and the other coated with china ink, or rather blown of deep black enamel. We consider two delicate thermometers of equal size filled with colourless alkohol, one of which has a dark coloured bulb, as a much better photometer. They should be both enclosed in the same cylinder of glass. We shall, however, transcribe Mr. Leslie's eloquent eulogium of his photometer.

The photometer, placed in open air, exhibits distinctly the progress of illumination from the morning's dawn to the full vigour of noon, and thence its gradual decline till evening *has spread her mantle;* it marks the growth of light from the winter solstice to the height of summer, and its subsequent decay, through the *dusky shades of autumn ;* and it enables us to compare, with numerical accuracy, the brightness of different countries, the brilliant sky of Italy, for instance, with the *murky atmosphere* of Holland. ....It may be mentioned as a curious inference, that the light emitted from the sun, is 12,000 times more powerful than the flame of a wax candle; or that if a portion of the luminous solar matter, *rather less* than an inch in diameter, were transported to our planet, it would throw forth a blaze of light equal to the effect of 12,000 candles†.

In the sixth section, the *Æthrioscope* is described : the name of another very delicate modification of the differential thermometer, intended to measure the *frigorific impressions* which are showered incessantly from the distant sky. A more convenient instrument for measuring the relation between the projection of heat from the surface of terrestrial bodies, and the counter-radiation from the sky, is obtained by placing the blackened bulb of a delicato mercurial thermometer, in the focus of an egg-shaped silver drinking cup. Its indications, compared with those of another, having its bulb at the side of the cup, will give good æthrioscopic intelligence.

The *Cyanometer* occupies the next section. This instrument was

* P. 346. † P. 348.

contrived by M. de Saussure, to measure the variable intensity of the cœrulean hue, which the sky assumes in different climates and elevations, according to the progress of the day, or advance of the season. It consists of 53 slips of paper, of about a quarter of an inch broad, stained with the successive shades of blue, from the palest sapphire to the deepest azure, which are pasted around the circumference of a circle of pasteboard, of about four inches in diameter. The colours were obtained from fine Prussian blue, diluting it with white chalk, or darkening it with a mixture of ivory black. He likewise compared those coloured spaces with the pure tints of a solution of copper in ammonia, which resemble most the soft transparent hues of the atmosphere. To represent the effect of clouds, and diffuse aqueous vapours, he dropped into that liquid a portion of very fine divided argillaceous earth, precipitated by ammonia from a solution of alum *.

We think with Mr. Leslie, that "it would be quite impossible to paint, with any water-colours, two cyanometers that should continue to agree, after being exposed for some time to the action of the air and the sun." But we conceive that the following arrangement would answer: A saturated solution of sulphate of copper, deepened by ammonia, enclosed in a glass vessel of a definite size, being assumed as the *maximum* depth of shade; that then the successive gradations could be accurately obtained by successive dilution of the blue liquid with water. Or the solution could be included between two planes of glass, joined together to form a wedge, the length of the side, and the thickness of the base of which, might be some definite measure. The side being graduated, and furnished with an eye-hole in a sliding plate of brass, the comparison of the sky-colour, to that of the liquid, might be accurately made.

The 8th, 9th, and 10th sections of Mr. Leslie's Dissertation, which treat of the *wind-gauge*, *rain-gauge*, and *electrometer*, contain nothing of particular interest. In the 11th, we have a short account of the *drosometer*, an instrument proposed in 1727, by Weidler, a German professor, to measure the quantity of dew which gathers on the surface of a body which has been exposed to the open air during the night. Dr. Wells, in his excellent Treatise on Dew, has furnished the ready mode of measuring the rate of this deposition, by the increase of weight which parcels of wool, exposed in different circumstances, acquire. Weidler's instrument consisted of a bent balance, which marked in grains the preponderance which a piece of glass of certain dimensions, laid horizontally in one of the scales, had acquired from the settling and adhesion of the globules of moisture. Mr. Leslie's proposal of spreading a "coat of deliqueate salt of tartar," with a hair pencil, over "the shallow surface" of a glass funnel, and renewing this coat as often as occasion may require, to facilitate the descent along its sides into a graduated glass tube, is such a project as no practical chemist would ever think of;

* P. 350.

for the indications of such an instrument would be altogether fallacious. After the description of the above contrivances, he concludes, "*Such* is the complete apparatus required for keeping a meteorological register." We have already given our reasons of dissent to this conclusion, with regard to the completeness of his apparatus, but we willingly concur in the following observations :

It cannot be expected that registers of the weather will possess much value, so long as they are kept merely as objects of curiosity. Like astronomical observations, as now conducted, they should no longer be left to the chance of individual pursuit. They would require to be unremittingly prosecuted in all variety of situations, and at the public expense. Proper sets of meteorological instruments should be placed not only in the regular observatories, but sent to the different forts and light-houses, both at home and at our principal foreign stations. They might also be distributed among the ships employed in discovery, or engaged on distant voyages. The cost of providing those instruments would be comparatively trifling, and the charge incurred, by keeping registers on a regular and digested plan, might shrink to nothing in the national expenditure*."

The sequel of this discourse on meteorology is occupied with *wind*; *clouds*, comprehending Hutton's hypothesis of rain, but no allusion to the valuable classification and nomenclature of Mr. Luke Howard, to whom meteorology is so eminently indebted; and *optical phenomena*, with supplemental quotations on the climate of the Arctic and Torrid zones.

The account which we have now given of Mr. Leslie's article on meteorology will enable our readers to judge of its general merits. Its prevailing feature is a display, in curious panegyrics, of *Mr. Leslie's* contrivances, and an unaccountable suppression or depreciation of the inventions of others, many of them certainly *not inferior* to his own. Van Helmont's air-thermometer has become a philosophical Proteus in his plastic hands. It is a *differential thermometer*, a *hygrometer*, a *photometer*, a *diaphanometer*, and an *æthrioscope*. His account, too, of these various modifications has more the air of a tradesman's advertisement, than of a philosopher's research; and its perusal by an indifferent reader would lead him to suppose that Mr. Leslie made the above instruments with his own hands, and sold them for his own profit. Lastly, the style is singularly artificial and inflated, affording a perfect contrast to the classical simplicity of his predecessors in the professorial chair.

After all, the most interesting relation of the atmosphere, in a meteorological point of view, is undoubtedly the hygrometric. Now, Mr. Leslie's instrument, (of which, he says, "it would essentially contribute to the advancement of meteorological science, if the hygrometer which we have described were introduced into general practice. This adoption cannot be very

* P. 354.

distant.")' gives no absolute measure of the moisture of the air. In this respect it is on a level with the whale-bone slip of De Luc, and the hair of Saussure. But on Mr. Daniell's plan, "the difference between the constituent temperature of the vapour, and that of the air, gives a *positive* measure of the state of the weather, the probability of aqueous precipitation from the atmosphere being inversely to the magnitude of this difference." Although the hygrometer of Mr. Daniell therefore excels all others in sensibility, and in the accuracy with which it marks the comparative degrees of the moisture and dryness in the atmosphere; and by exhibiting them in degrees of the common thermometer, refers them to a known standard of comparison, thus speaking a language which every body understands; yet it is not upon this alone that its claims to superiority are founded. *Its great merit consists in indicating, with ease and precision, the positive weight of aqueous gas, diffused through any given portion of space, and the force and elasticity of vapour, as measured by the column of mercury which it is capable of supporting.* It may be also applied to indicate the force and quantity of evaporation.

We now take our leave of Mr. Leslie, "more in sorrow than in anger," regretting that a philosopher of his acknowledged talents, holding, as he does, an eminent station in one of the first universities of Europe, and advantageously known to the scientific world by many interesting researches and ingenious inventions, should indulge in the whimsical speculations and strange vagaries contained in the subject of our Review. These "quiddits and quillets" might possibly pass current in a metaphysical debating Society, but they ought not to have been *published* by the Professor of Natural Philosophy in the University of Edinburgh.

Art. XI. — ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XI.

i. *A Catalogue of the Polar Distances of Thirty nine principal Stars. By the* Rev. John Brinkley, D.D., *&c. &c. &c.*

No.	Names of the Stars.	Mean N. P. D. Jan. 1, 1820.	Ann. Var. 1810.	Ann. Var. 1820.	Ann. Var. 1830.	Proper Motion	Err. Cat. 1813.
		° ′ ″	″	″	″	″	″
1	γ Pegasi	75 49 0.58	−20.079	−20.077	−20.076	−0.037	+0.06
2	α Cassiopeiæ ..	34 27 3.67	19.872	19.865	19.856	+0.004	−0.13
3	Polaris	1 39 5.60	19.498	19.447	19.376	−0.012	−0.05
4	α Arietis	67 23 35.85	17.402	17.377	17.352	+0.109	−0.73
5	α Ceti	86 37 19.80	14.562	14.530	14.498	+0.076	+0.53
6	Aldebaran ...	73 51 41.27	7.926	7.880	7.834	+0.144	−0.45
7	Capella	44 11 49.63	4.541	4.498	4.455	+0.401	−0.41
8	β Tauri	61 33 17.88	3.792	3.738	3.684	+0.179	+0.17
9	α Orionis	82 38 7.86	− 1.337	− 1.290	− 1.243	−0.017	−0.95
10	Sirius	106 28 35.09	+ 4.414	+ 4.451	+ 4.489	+1.211	+0.34
11	Castor	57 43 37.29	7.128	7.164	7.199	+0.054	+0.40
12	Procyon	84 19 16 96	8.653	8.695	8.737	+1.035	−0.77
13	Pollux	61 32 52.98	8 015	8.064	8.113	+0.048	−0.46
14	Regulus	77 9 24.84	17.263	17.286	17.308	−0.019	−0.78
15	α Ursæ Maj...	27 16 46.16	19.260	19.275	19.290	+0.094	−0.36
16	β Ursæ Maj...	32 39 18.71	19.110	19.125	19.140	−0.015	−0.12
17	β Leonis	74 25 17.76	20.047	20.049	20.052	+0.083	−0.98
18	γ Ursæ Maj...	35 18 15.15	19.999	20.001	20.004	+0.005	+1.00
19	δ Ursæ Maj...	33 3 39.14	19.707	19 698	19.689	+0.058	+0.80
20	Spica Virginis	100 13 5.08	19.002	18.986	18.971	+0.027	−0.85
21	ζ Ursæ Maj...	31 7 53.55	18.970	18 958	18.945	+0.025	+1.84
22	η Ursæ Maj...	39 47 5.38	18.186	18.170	18.154	+0.021	+0.18
23	Arcturus	69 52 32.65	19.002	18.980	18.958	+1.957	−0.46
24	β Ursæ Min. ..	15 6 32.44	14.763	14.765	14.767	+0.007	+0.36
25	α Cor. Bor.	62 49 22.95	12.473	12.443	12.413	+0.039	−0.34
26	α Serpentis	83 0 1.46	11.768	11.733	11.698	−0.090	−0.52
27	α Ophiuchi	77 18 1.33	3 118	3.078	3.038	+0.166	+0.71
28	γ Draconis	38 29 8.21	+ 0.705	+ 0.685	+ 0.665	+0.023	+0.28
29	α Lyræ	51 22 39.84	− 2.970	− 2.999	− 3.028	−0.309	+0.01
30	γ Aquilæ	79 49 2.91	8.296	8.334	8.371	−0.016	+0.09
31	α Aquilæ	81 35 56 05	9.014	9.052	9.090	−0.423	+0.44
32	β Aquilæ	84 2 4.60	8.525	8.563	8.601	+0.417	+0.68
33	1 α Capricorni	103 3 21.60	10.602	10.642	10.683	−0.016	0.00
34	2 α Capricorni	103 5 39.03	10.636	10.677	10.718	−0.051	−1.74
35	α Cygni	45 21 29.73	12 567	12.590	12.612	−0.024	+0.48
36	α Cephei	28 10 27.84	15.027	15.040	15.053	−0.013	+0.78
37	β Cephei	20 13 41.35	15.650	15.657	15.663	+0.045	+0.46
38	α Aquarii	91 11 22.03	17.227	17.248	17.271	−0.044	−1.02
39	α Andromedæ .	61 54 11.75	19.933	19.932	19.931	+0.112	−0.95

The observations, from which the preceding catalogue was deduced, were made in the years 1818, 19, 20, and 21. Most of the polar distances here given are easily deduced from the results given in my paper in the *Phil. Trans.* 1821.

These polar distances having been compared with the results of Dr. Bradley's observations, as deduced by Mr. Bessel for the year 1755, the proper motions here given were obtained.

The annual precession (to which the proper motion is applied) was computed for each star from the numbers in Mr. Bessel's deductions, viz.:—

$$\text{Præc. in NPD} = -(20'',05039 - ,00009702\,t)\cos \text{AR}.$$
$$t = \text{given year} - 1750.$$

From these polar distances and annual variations have been deduced the NPD in 1813, and a comparison made with the polar distances deduced from observations in 1812, 13, and 14. (*Vide* 12 *vol., Trans. R. I. A.*)

The differences of the catalogue of 1813 appear by this comparison to be very small, and thereby is shown the consistency of the instrument. The number of observations, from which the catalogue of 1813 was deduced, were much indeed inferior to those by which the catalogue of 1820 has been determined.

The column of proper motions is probably exact to $\frac{2}{100}$ of a second, and the error of the columns of annual variation cannot be much greater.

ii. *Polar Distances of the 39 Stars, from different Catalogues.*

No.	N. A. 1825.	Diff. N. A. 1824, Cancel.	Diff. Br.	Diff. N. A. 1823.	Diff. Bessel, 1822.
1	75° 49′ 0″ ?	0″	+ 1″	+ 0″	+ 4″
2	34 27 5	− 1	− 1	− 1	
3	1 39 5.5	0	+ 0	+ 0	
4	67 23 36	+ 1	− 0	− 1	+ 2
5	86 37 20	− 2	− 0	− 2	+ 2
6	73 51 41	+ 2	+ 0	− 1	+ 2
7	44 11 51	0	+ 1	− 3	− 0
8	61 33 18	− 1	− 0	− 1	+ 2
9	82 38 8	0	− 0	− 2	+ 1
10	106 28 36	0	− 1	− 5	+ 1
11	57 43 38	+ 1	− 1	− 2	+ 1
12	84 19 18	+ 1	− 1	− 2	+ 2
13	61 32 53	+ 2	− 0	− 1	+ 1
14	77 9 24	0	+ 1	− 0	+ 2
15	27 16 46	− 1	+ 0	+ 1	
17	74 25 18	0	− 0	− 0	+ 2
18	35 18 5	[+ 4]*			
20	100 13 4	− 1	+ 1	− 1	+ 4
22	39 47 5	− 1	+ 0	+ 0	
23	69 52 32	+ 1	+ 1	− 0	+ 3
24	15 6 31	0	+ 1	+ 1	
25	62 40 23	0	− 0	− 0	+ 3
26	83 0 2	+ 1	− 1	− 1	+ 3
27	77 18 1	+ 1	+ 0	− 0	+ 3
28	38 29 9	0	− 1	− 0	
29	51 22 40	0	− 0	− 0	+ 2
30	79 49 2	0	+ 1	+ 0	+ 4
31	81 35 56	+ 1	+ 0	− 1	+ 3
32	84 2 4	0	+ 1	+ 0	+ 5
33	103 3 20 ?	+ 1	+ 2	+ 1	+ 6
34	103 5 37 ?	0	+ 2	+ 0	+ 6
35	45 21 30	0	− 0	− 1	+ 2
36	28 10 28	− 1	+ 1	+ 0	
37	20 13 40	0	+ 1	+ 1	
38	91 11 22	− 1	+ 0	− 1	+ 3
39	61 54 12	+ 1	− 0	− 2	+ 1

* An error in computation.

The *supposed* probable error of Bessel is generally about $\frac{1}{4}''$, and never amounts to $\frac{1}{2}''$, while the difference from the other

catalogues varies gradually with the polar distance from 0″ to 5″! This is a good example of the inutility of the modern theory of probabilities, as it has been frequently employed on the continent.

iii. *Elements of a Table of Refraction, deduced from Observation only.*

Star	Observations	Altitude	Refraction Fa. 48°	B. 30 Fa. 46°	Correction for —1° F.
		° ′			
γ Cygni	13 Groombr.	1 31	20 56.1	21 3.2	3.54
α Lyræ	44 Brinkl.	2 17½	16 53.9	16 59.5	2.81
α Cygni	9 Groombr.	6 15	8 9.4	8 11.5	1.07

The method of reduction employed has been this: First, To correct the height of the barometer for the small difference of temperatures, so as to make it a *barometer without.* Secondly, To reduce all the refractions to their mean value, with the barometer at 30 inches, by applying corrections simply proportional to the differences, as usual. Thirdly, To find the mean temperature by the *exterior thermometer.* Fourthly, To find the differences of the several temperatures from the mean, and add them all together, without regard to the signs. Fifthly, To find the mean refraction and the differences from the mean, and to add together such of them as are regular, that is, such as agree with the differences of the thermometer in their character, and to subtract the sum of such as are irregular. Sixthly, To divide this result by the sum of the differences of the thermometer, in order to obtain the experimental correction for temperature. Seventhly, To apply this correction to the reduction of the mean temperature of the thermometer to 48° or 46°: and Lastly, To reduce the mean apparent altitude to the nearest minute, according to the differences of any existing table, for the more ready comparison of the results of this method of reduction with those of any theory to be examined.

A ninth step will be required, with respect to the correction for temperature, if we wish to determine it with great accuracy; that is, to correct the mean altitude for any supposed temperature, and to add to the correction found the difference

of the refraction for this corrected altitude: thus, adding, in the first example 3″,54 to the mean altitude 1° 31′, the refraction ought to become less by about $\frac{1}{60} \times 5''{,}9 \times 3.54 = ''{,}35$, and the true correction for — 1° F. is therefore 3″,89. In the same manner we find, for 2″,81, 3″,01; and for 1″,07, 1″,09. It is impossible for *unselected* examples to agree better with a theory than these do with the table in the Nautical Almanac, of which the numbers are 3″,88, 2″,85, and 1″,10 respectively; while the French tables give us 2″,5, 2″,0, and 0″,98 only.

iv. *Remarks on the Astronomical Measurements of the Ancients.*

There is a passage in Plutarch, as quoted by Eusebius in his *Evangelical Preparation,* which determines the distance of the sun from the earth to be about 95 millions of miles, according to Sir William Drummond's computation of the length of the stadium, published a few years since in the *Classical Journal.* The circumstance must be allowed to be very remarkable, and seems at first sight to indicate an astonishing precision of observation, without the possession of any accurate instruments: but a little consideration is sufficient to convince us, that to an astronomer unprovided with a telescopic micrometer, it was utterly impossible to ascertain an angle of any kind even without a probability of error of half a minute, much more to come within one-tenth of a second of the truth in the measurement of seven or eight seconds. Indeed the very utmost that could be expected from the observation of the moon's disc at the quadratures, would be to make it probable that there was a sensible though a very small parallax, but whether of a second or a minute could certainly not be conjectured without a telescope; and the perfect coincidence of Plutarch's report of the determination of Eratosthenes with the true measure must have been wholly accidental: a conclusion which is still further confirmed by the extreme inaccuracy of the statement of the moon's distance in the same passage, though the moon's parallax was pretty well known to Eratosthenes, as well as the earth's dimensions.

There is on this subject a singular confusion in the remark of Laplace, that Eratosthenes found the difference of latitude of Syene and Alexandria equal to $\frac{1}{50}$ of the circumference: and this distance being estimated at 500[0] stadia, Eratosthenes inferred that the whole circumference was 250,000. " But," he continues, " the uncertainty of the value of the stadium, employed by this astronomer, renders it impossible to appreciate the accuracy of this measurement."—*Exp. du Syst. du Monde*, V. ii.

Now it is highly improbable that Eratosthenes should have committed any *gross* error in the measurement of the length of Egypt from north to south, and we may surely consider it as a *sufficient* determination of the stadium which he employed, that it was $\frac{1}{5000}$ of the difference of latitude between Alexandria and Syene, or between 31° 13′ and 24° 5′, which is 7° 8′, or about 498 English miles; and 50 times this distance is 24,900, giving 7,930 miles for the earth's diameter: a result very fairly obtained from the operations of Eratosthenes, and as correct in reality as the distance of the sun in Plutarch has been rendered by accident only. Nor will the variation be material if we take the number 252,000, from Pliny, instead of 250,000 stadia, as the exact extent assigned by Eratosthenes to the earth's circumference.

In referring to some of these numbers, we may observe one thing with respect to the numeration of the Romans, which has not been commonly noticed: that is, that though they had not invented a *decimal* arithmetic, they occasionally employed a *centenary* notation: thus in Pliny's fifth book, chapter ix., we have XXVI.XXXIX mill. passuum, for 2639 miles, and again XV.XLV, for 1545; the word *centena* being omitted, as was also usual in their computations of money: but they do not seem to have made any further step, either upwards or downwards, in the decimal scale.

ART. XII. *Corrections in Right Ascension of Thirty-six Principal Stars. By* JAMES SOUTH, F.R.S.

[Concluded from Vol. XIII., p. 393.]

OCT.	γ Pegasi.	α Arietis.	α Ceti.	Aldebaran	Capella.	Rigel.	β Tauri.	α Orionis.	Sirius.	Castor.	Procyon.	Pollux.	α Hydræ.	Regulus.	β Leonis.	β Virgin.	Spic. Vir	Arcturus.
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
1	+4.22	+4.45	+4.13	+4.08	+5.03	+3.38	+4.24	+3.54	+2.65	+3.68	+2.90	+3.47	+2.12	+2.36	+1.98	+1.97	+1.85	+1.70
2	22	46	14	10	07	41	27	56	67	71	93	50	14	38	99	98	85	70
3	23	48	16	13	11	43	30	59	70	74	96	54	17	40	+2.00	+2.00	86	69
4	23	49	18	16	15	46	33	62	73	78	99	57	19	42	01	01	86	69
5	23	50	20	19	19	49	37	65	76	81	+3.01	60	21	44	03	02	86	68
6	24	52	22	21	23	51	40	68	79	85	04	64	24	46	04	03	86	68
7	24	53	24	24	27	54	43	71	82	88	07	67	26	48	05	04	86	67
8	24	54	26	27	31	57	46	74	85	92	10	70	28	50	07	06	87	67
9	24	56	27	29	35	59	49	77	88	95	13	74	31	53	08	07	87	67
10	24	57	29	32	38	62	52	79	90	99	16	77	33	55	10	09	88	67
11	24	58	30	34	42	64	55	82	93	+4.02	19	80	36	58	11	10	89	67
12	24	59	32	37	46	67	58	85	96	06	22	83	38	60	13	12	89	67
13	25	61	34	40	50	70	62	88	99	10	25	87	41	63	15	14	90	67
14	25	62	35	43	54	72	65	91	+3.03	14	28	90	43	65	16	15	91	67
15	25	63	37	46	58	75	68	93	06	18	31	93	46	68	18	17	92	67
16	25	66	39	49	62	78	72	97	09	22	35	97	49	71	21	20	94	63
17	25	68	41	52	66	81	76	+4.00	12	26	38	+4.01	52	74	23	22	95	68
18	25	69	42	54	70	83	79	03	15	30	41	04	55	77	25	24	96	68
19	24	69	44	56	74	86	82	05	18	33	44	08	58	79	27	26	97	69
20	24	70	45	59	77	88	85	08	21	37	47	11	60	82	29	28	98	69
21	24	71	47	61	81	91	88	11	24	40	50	15	63	85	31	30	99	70
22	24	71	48	63	84	93	91	13	26	44	53	18	66	87	32	31	+2.00	70
23	23	72	49	65	88	95	94	16	29	48	56	22	69	90	34	33	02	70
24	23	73	51	67	91	98	97	19	32	51	59	25	72	93	36	35	03	71
25	23	74	52	70	95	+4.00	+5.00	22	35	55	62	29	74	96	38	37	04	71
26	22	74	54	72	98	03	03	24	38	58	65	32	77	98	40	39	05	72
27	22	75	55	74	+6.02	05	06	27	41	62	68	36	80	+3.01	42	41	06	72
28	22	76	56	76	05	07	09	30	44	65	71	39	83	04	44	43	07	73
29	21	76	57	78	08	09	11	32	46	69	74	43	86	07	47	46	08	74
30	21	77	58	80	12	12	14	35	49	72	77	46	89	10	49	48	09	75
31	20	78	59	82	15	14	17	37	52	76	80	50	92	13	52	50	10	76

OCT. continued	α Libræ.	α Cor.Bor.	α Serpent.	Antares.	α Herculis	α Ophiuch	α Lyræ.	γ Aquilæ.	α Aquilæ.	β Aquilæ.	α Capric.	α Cygni.	α Aquarii.	Fomalh.	α Pegasi.	α Androm.	Polaris.
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	H. M. S.
1	+2.15	+1.68	+2.12	+2.93	+2.29	+2.43	+1.95	+3.15	+3.25	+3.31	+3.90	+2.62	+4.03	+4.85	+4.01	÷4.21	0 . 58 . 12.32
2	14	67	11	92	28	42	93	14	24	29	89	59	03	85	01	21	12.56
3	13	65	09	90	26	40	90	12	22	27	87	57	02	84	01	21	12.76
4	13	64	08	89	24	38	88	10	20	26	86	54	01	84	00	21	12.97
5	12	63	07	88	22	36	85	08	18	24	84	52	00	83	00	22	13.17
6	12	61	06	86	21	35	83	07	17	23	83	49	+3.99	83	+3.99	22	13.33
7	11	60	05	85	19	33	80	05	15	21	81	47	98	82	99	22	13.45
8	11	59	04	84	18	31	78	03	13	19	80	45	97	81	98	22	13.47
9	10	58	04	83	16	30	75	02	11	18	78	42	96	80	98	22	13.46
10	10	57	03	82	15	28	73	00	10	16	76	40	95	80	97	22	13.42
11	10	56	02	81	13	27	70	+2.99	09	15	75	37	94	79	97	23	13.40
12	10	55	02	80	12	25	68	97	07	13	74	35	94	78	96	23	13.39
13	09	51	01	78	10	23	66	95	05	11	72	33	93	77	95	23	13.35
14	09	53	00	77	09	22	63	94	04	10	71	30	92	77	95	23	13.36
15	09	52	00	76	07	20	61	93	03	09	70	28	91	76	94	23	13.41
16	10	52	00	76	08	21	59	92	02	08	69	26	91	76	94	23	13.49
17	10	51	00	75	06	19	57	90	00	06	67	24	90	75	94	22	13.59
18	10	51	00	74	05	18	55	88	+2.98	04	65	21	89	74	93	22	13.62
19	10	50	+1.99	74	04	17	52	87	97	03	64	19	87	73	93	22	13.63
20	11	50	99	73	02	15	50	85	95	01	62	16	86	72	92	22	13.60
21	11	49	98	72	01	14	48	83	93	00	61	14	85	71	91	21	13.53
22	11	49	98	72	00	13	46	81	92	+2.98	59	11	84	70	90	21	13.42
23	11	48	98	71	+1.99	12	43	79	90	96	57	08	82	68	89	21	13.23
24	11	48	97	70	98	11	41	77	88	95	56	06	81	67	88	20	13.03
25	12	47	97	69	96	09	39	76	86	93	54	03	80	66	87	20	12.84
26	12	47	96	69	95	08	36	74	85	92	53	01	78	65	86	20	12.67
27	12	46	96	68	94	07	34	72	83	90	51	+1.98	77	64	85	19	12.53
28	13	46	96	68	93	06	32	70	82	89	50	95	76	63	84	18	12.37
29	14	46	96	68	92	05	30	69	80	87	48	92	74	62	83	17	12.26
30	14	46	96	67	92	04	28	68	79	86	47	90	73	60	82	17	12.17
31	15	46	96	67	91	03	26	67	74	84	45	88	72	59	81	16	12.09

NOV.	γ Pegasi.	α Arietis.	α Ceti.	Aldebaran	Capella.	Rigel.	β Tauri.	α Orionis.	Sirius.	Castor.	Procyon.	Pollux.	α Hydræ.	Regulus.	β Leonis.	β Virginis	Spica Vir.	Arcturus.
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″
1	+4.20	+4.78	+4.60	+4.84	+6.18	+4.16	+5.19	+4.40	+3.54	+4.79	+3.82	+4.53	+2.95	+3.16	+2.54	+2.52	+2.13	+1.76
2	20	79	61	86	21	18	22	43	57	83	85	56	99	20	56	55	15	77
3	19	80	62	88	24	21	25	46	60	87	88	60	+3.02	24	59	57	17	78
4	19	81	64	91	27	24	28	49	63	91	92	64	06	27	62	60	19	80
5	18	82	66	93	30	27	31	52	66	95	96	68	09	30	65	63	20	81
6	18	83	67	95	33	29	34	55	69	98	99	72	12	33	67	65	22	82
7	17	83	68	97	36	31	36	57	72	+5.01	+4.02	75	15	36	70	68	24	83
8	17	84	69	99	39	33	39	60	74	05	05	79	18	39	72	70	26	85
9	16	84	69	+5.00	42	35	41	62	77	08	08	82	21	42	75	73	28	86
10	15	84	70	02	45	37	44	65	80	12	11	86	24	45	78	76	30	88
11	14	84	71	04	48	39	46	67	82	15	14	89	27	48	80	78	32	89
12	13	85	72	06	51	41	48	69	85	19	17	92	31	52	83	81	34	90
13	12	85	73	08	54	43	51	72	88	22	20	96	34	55	86	84	36	92
14	12	85	73	09	57	45	53	74	91	26	23	99	37	58	89	87	38	93
15	11	86	74	11	60	47	56	77	93	29	26	+5.03	40	61	91	89	40	95
16	10	86	75	13	63	49	58	79	96	32	29	06	43	64	94	92	42	96
17	09	86	75	15	66	51	69	81	98	36	32	09	46	67	97	95	44	98
18	08	86	76	16	69	52	62	83	+4.01	40	35	12	49	71	+3.00	98	47	+2.00
19	07	87	76	18	72	54	64	85	03	44	38	16	53	74	03	+3.01	49	02
20	07	87	77	20	75	56	66	87	06	48	41	19	56	78	06	04	52	04
21	07	87	77	22	78	57	68	89	08	52	44	22	59	81	09	07	55	06
22	06	87	78	24	81	60	71	92	11	55	47	26	63	85	13	10	58	09
23	06	88	78	26	83	62	73	95	14	58	50	29	66	89	16	13	61	11
24	05	88	79	28	86	64	75	97	16	61	53	33	70	92	19	16	63	13
25	04	88	79	29	88	65	77	99	19	65	56	36	73	96	22	19	66	15
26	03	88	79	31	91	67	79	+5.01	21	68	59	39	76	99	25	22	68	17
27	02	87	80	32	93	68	82	03	23	71	61	42	79	+4.02	28	25	71	19
28	01	87	80	33	94	69	84	04	25	74	64	45	82	05	31	28	73	21
29	00	87	80	34	96	71	86	06	27	77	66	48	85	09	34	31	76	24
30	+3.99	86	81	35	98	72	87	08	29	80	69	51	87	12	37	34	79	26

NOV. continued	α Libræ.	α Cor.Bor.	α Serpent.	Antares.	α Herculis	α Ophiuchi	α Lyræ.	γ Aquilæ.	α Aquilæ.	β Aquilæ.	α Capric.	α Cygni.	α Aquarii.	Fomalh.	α Pegasi.	α Androm.	Polaris.
	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	″	H. M. s.
1	+2.16	+1.46	+1.96	+2.67	+1.90	+2.02	+1.25	+2.65	+2.76	+2.83	+3.44	+1.85	+3.71	+4.58	+3.80	+4.15	0 . 58 . 11.99
2	17	46	96	67	89	01	23	63	75	81	43	82	69	57	79	14	11.82
3	18	46	96	67	89	00	21	62	74	80	41	80	68	56	78	13	11.61
4	19	47	97	68	88	00	20	61	73	80	42	79	69	55	79	14	11.36
5	20	47	97	68	88	+1.99	18	60	72	79	40	77	67	54	78	13	11.07
6	21	47	97	68	87	98	16	59	71	77	39	74	66	53	77	12	10.75
7	22	48	98	68	87	98	14	58	70	76	38	72	65	52	76	11	10.38
8	24	48	98	69	86	97	13	57	68	74	36	69	63	50	75	10	10.03
9	25	49	99	69	86	97	11	55	67	73	35	67	62	49	73	09	9.69
10	26	49	99	69	86	96	09	54	66	72	34	64	61	47	72	08	9.38
11	27	50	+2.00	69	86	96	08	53	65	71	33	62	60	46	71	08	9.12
12	29	51	01	70	85	95	06	52	63	69	31	60	58	45	70	07	8.84
13	30	51	01	70	85	95	04	51	62	68	30	57	57	43	69	06	8.59
14	31	52	02	70	85	94	02	49	61	67	29	55	56	42	67	05	8.34
15	33	52	02	71	84	94	01	48	59	65	27	52	54	40	66	04	8.08
16	34	53	03	71	84	93	+0.99	47	58	64	26	50	53	39	65	03	7.77
17	36	54	04	72	84	93	98	46	57	63	25	48	52	38	64	02	7.39
18	37	55	05	73	84	93	97	45	56	62	24	46	51	36	63	01	6.96
19	39	56	07	73	84	93	96	44	55	61	23	43	49	35	61	00	6.49
20	41	57	08	74	84	93	95	43	54	60	22	41	48	33	60	+3.99	6.00
21	42	58	09	76	84	93	94	42	54	60	22	39	47	32	59	98	5.51
22	45	60	11	77	86	94	93	42	54	60	22	38	47	32	59	98	5.00
23	48	62	12	78	86	94	92	41	53	59	21	36	46	30	58	97	4.51
24	50	63	14	79	86	94	91	40	52	58	20	33	44	29	56	96	4.05
25	51	64	15	80	86	94	90	39	51	57	19	31	43	27	55	95	6.64
26	53	65	16	81	86	94	89	38	50	56	18	29	42	26	54	94	3.27
27	55	66	17	82	86	94	88	37	49	55	17	27	41	25	53	93	2.86
28	57	68	19	84	87	95	87	37	48	54	16	25	40	23	51	91	2.44
29	59	69	20	85	87	95	86	36	48	54	15	23	38	22	50	90	2.01
30	61	71	22	86	88	95	85	35	47	53	14	21	37	20	49	89	1.55

DEC.	γ Pegasi.	α Arietis.	α Ceti.	Aldebaran	Capella.	Rigel.	β Tauri.	α Orionis.	Sirius.	Castor.	Procyon	Pollux.	α Hydræ.	Regulus.	β Leonis.	β Virginis.	Spica Vir.	Arcturus.
1	+3.98″	+4.86″	+4.81″	+5.35″	+6.99″	+4.73″	+5.89″	+5.09″	+4.31″	+5.83″	+4.71″	+5.54″	+3.91″	+4.15″	+4.40″	+3.37″	+2.81″	+2.28″
2	96	85	81	36	+7.01	74	91	11	33	86	74	57	94	18	44	41	84	30
3	95	85	81	37	03	75	92	13	35	89	76	60	97	21	47	44	87	32
4	[illegible]4	84	81	38	05	77	94	15	37	92	79	63	+4.00	25	50	47	90	35
5	93	84	82	39	06	78	95	16	39	95	82	66	03	28	53	50	92	37
6	92	83	82	40	08	79	97	18	41	98	84	69	06	31	56	53	95	39
7	91	82	82	41	09	80	98	19	43	+6.01	86	72	09	34	59	56	98	42
8	90	82	82	41	11	81	+6.00	21	45	03	89	75	12	37	63	60	+3.01	44
9	89	81	82	42	12	82	01	23	47	06	91	78	15	40	66	63	04	47
10	88	81	82	43	14	83	03	25	49	09	94	81	18	44	70	67	08	50
11	87	81	82	44	16	84	04	26	51	12	96	83	21	48	74	70	11	53
12	86	80	82	45	18	85	06	27	53	15	98	86	24	51	77	74	14	56
13	85	80	82	46	20	86	07	29	55	17	+5.00	89	27	54	81	77	17	59
14	84	79	81	47	21	87	08	30	56	20	03	92	30	58	84	80	20	62
15	83	79	81	47	22	88	09	32	58	22	06	94	33	61	88	84	23	64
16	82	78	81	48	23	89	10	33	60	25	08	96	36	64	91	87	26	67
17	81	77	81	48	24	90	11	34	61	27	10	98	39	67	94	90	29	70
18	80	76	80	49	25	90	12	35	62	29	12	+6.01	41	70	98	93	32	73
19	79	75	80	49	25	91	13	36	64	32	14	04	44	73	+4.01	97	35	76
20	78	74	79	49	26	91	14	37	65	34	16	06	47	76	04	+4.00	38	79
21	77	74	79	49	26	92	15	38	66	36	18	08	49	79	07	03	41	81
22	76	73	78	50	27	93	16	39	68	38	20	10	52	82	11	06	45	84
23	75	72	78	50	27	93	17	40	69	40	21	12	55	85	14	09	48	87
24	74	71	77	50	28	94	17	41	70	43	23	15	58	88	17	13	51	90
25	73	70	77	51	29	94	18	42	72	45	25	17	60	91	20	16	54	93
26	72	69	76	51	30	95	19	43	73	47	27	19	63	94	24	19	57	96
27	71	69	76	51	31	95	20	44	74	49	29	21	66	97	27	22	61	99
28	70	68	75	52	33	96	21	45	75	51	31	23	68	+5.00	30	25	65	+3.02
29	69	68	75	52	35	96	22	46	77	53	33	25	71	03	34	28	69	06
30	68	67	75	53	37	97	23	47	79	56	35	28	74	07	38	31	+3.73	10
31	67	67	74	53	40	97	24	48	80	58	37	30	77	10	42	34	76	14

DEC. continued	α Libræ.	α Cor.Bor.	α Serpent.	Antares.	α Herculis	α Ophiuch	α Lyræ.	γ Aquilæ.	α Aquilæ.	β Aquilæ.	α Capric.	α Cygni.	α Aquarii	Fomalh.	α Pegasi.	α Androm.	Polaris.
	″	″	″	″	″	″	″	″	″	′	″	″	″	″	″	″	H. M. S.
1	+2.63	+1.72	+2.23	+2.87	+1.88	+1.95	+0.84	+2.35	+2.46	+2.52	+3.14	+1.19	+3.36	+4.19	+3.48	+3.88	0 . 58 . 1.04
2	66	74	24	89	89	96	83	34	45	51	13	16	35	17	46	86	0.46
3	68	75	26	90	89	96	82	33	44	50	12	15	34	16	45	85	0 . 57 . 59.84
4	70	77	27	91	90	96	82	32	44	50	11	12	32	14	44	84	59.21
5	72	78	29	93	90	97	81	32	43	49	10	10	31	13	42	82	58.58
6	74	80	30	94	91	97	81	31	42	48	09	08	30	11	41	81	57.96
7	76	82	32	96	92	98	80	31	42	48	09	06	29	10	40	80	57.34
8	79	84	34	98	93	99	80	30	42	47	08	05	28	09	39	78	56.76
9	81	86	36	+3.00	94	99	80	30	42	47	08	03	27	07	37	77	56.22
10	84	89	39	02	95	+2.01	80	30	42	48	09	03	27	07	37	78	55.71
11	87	91	41	04	97	02	80	30	42	48	09	01	26	06	36	77	55.21
12	90	93	43	06	99	03	80	30	42	47	08	+0.99	26	05	35	75	54.68
13	92	95	45	08	+2.00	04	80	30	42	47	08	98	25	04	34	74	54.11
14	95	97	47	10	01	04	79	30	42	47	08	96	24	02	32	73	53.52
15	97	99	49	12	02	05	79	29	41	46	07	95	23	01	31	71	52.87
16	+3.00	+2.01	51	14	03	06	79	29	41	46	07	93	22	00	30	70	52.18
17	03	03	53	16	04	07	79	29	41	46	07	92	21	+3.99	29	69	51.44
18	06	06	56	18	06	08	79	29	41	46	07	91	20	97	28	67	50.68
19	09	08	58	21	07	10	79	29	41	46	07	89	20	96	27	66	49.95
20	12	11	60	23	09	11	79	29	42	46	07	88	19	95	26	64	49.24
21	14	13	62	25	10	13	79	29	42	46	07	87	18	94	25	63	48.56
22	17	15	65	27	12	14	80	30	42	47	06	86	17	92	23	62	47.90
23	20	18	67	29	13	16	80	30	42	47	06	85	16	91	22	60	47.28
24	23	20	69	32	15	17	80	30	42	47	06	83	16	90	21	59	46.67
25	26	23	72	34	16	19	80	30	42	47	06	82	15	88	20	57	46.07
26	29	25	74	36	18	20	80	31	43	47	06	81	14	87	19	56	45.46
27	32	28	77	39	20	22	80	31	43	47	06	80	13	86	18	55	44.80
28	35	31	79	41	22	23	81	31	43	47	06	79	13	85	17	53	44.12
29	39	33	82	44	24	25	81	31	43	48	07	78	12	84	16	52	43.39
30	+3.43	36	85	47	26	27	83	32	43	49	08	79	13	83	17	51	42.69
31	46	39	88	50	28	29	83	32	43	49	08	78	12	82	16	50	41.84

Art. XIII. PROGRESS OF FOREIGN SCIENCE.

CHEMICAL SCIENCE.

I. Laws of Combination.

On the Relation which exists between Crystalline Form and Chemical Proportions. By Mr. E. Mitscherlich*.

The light which the theory of definite proportionals has thrown upon chemistry, the mechanical views by which the atomic philosophy accounts for fixed proportions, the use which has been made of these views to represent bodies composed of a determinate number of atoms, have engaged M. Mitscherlich to examine the following problem: Different elements being combined with the same number of atoms of one or of several other elements, have they the same crystalline form? Is the identity of the crystalline form determined only by the *number* of atoms? Is this form independent of the chemical *nature* of the elements?

Accident led him, in his first endeavours, to a series of combinations which furnished an affirmative reply to all the preceding questions, so that he was on the point of regarding his results as a general law. He operated at first on some single and double sulphates; that is to say, on the sulphates of potash, ammonia, and magnesia, of the protoxide of iron and manganese, of the oxide of zinc, copper, cobalt, and nickel. But having extended his researches to combinations of the same base with other acids, which, according to the atomic theory, have the same number of atoms as sulphuric acid, or to combinations of sulphuric acid with bases having an analogous composition, he found that this identity of crystalline form did not necessarily hold. This observation induced him to make researches on the chemical combinations which, by the atomic theory, seem to have an analogous composition, in order to study the cause of the identity or difference of their crystalline form. The trials made with this view seem to demonstrate that certain different elements, combined with the same number of one or of several elements, affect the same crystalline form; and that chemical elements, in general, may in this respect be classed in groups. He gives the epithet *isomorphous* to those elements which belong to the same group, in order to express this quality of the elements by a technical term. He has not been able hitherto to investigate how many isomorphous groups there are, nor to determine all the elements which belong to one or other of these groups. Perceiving, however, that a vast field was opened to new researches, and that a key was given to lay open a question of so great importance to chemistry, a question at the same

* Translated from the Memoirs of the Academy of Stockholm, by the author, for the *Annales de Chim. et de Phys*., xix. 350.

time which will have a great influence on the future state of mineralogy, he has conceived it his duty to submit this idea to public discussion.

The result of his trials on the above-mentioned sulphates was published in the *Memoirs of the Academy of Berlin* for 1818 and 1819, and in the *Annales de Chim. et de Phys.* for July, 1820. The researches of M. Berzelius have shewn, says he, that the acids of phosphorus and arsenic, that is, the phosphoric, phosphorous, arsenic, and arsenious, are analogous in their composition, but different from all the other acids; and that in their combinations with the bases, they follow the same law, which, however, departs from that which all other oxidized bodies obey in their combinations *. On account of the extraordinary identity of chemical composition in these salts, he thought it right to employ them in preference, for the examination of the idea just announced. Berzelius found that the quantity of oxygen with which phosphorus combines to form phosphoric acid, is to that which produces phosphorous acid with the same quantity of phosphorus, in the ratio of 5 to 3. M. Dulong, without knowing the labours of Berzelius, was led, by his own experiments, to the same result. Berzelius has since found, by a long series of experiments, that the same relation exists in the composition of the arsenious and arsenic acids. M. Mitscherlich's researches have brought him to the same conclusion.

The number of proportions which the phosphoric and arsenic acids contain determines directly the ratio in which these acids combine with the bases; but it is not merely in this identity of composition that the two series of salts formed by these oxides resemble each other, for we shall see that they have, under every point of view, an almost perfect identity in their composition and in their characters. Every arseniate has a phosphate which corresponds to it, composed according to the same proportions, combined with the same atoms of water of crystallization, and which, at the same time, has the same physical qualities. In a word, these two series of salts differ in no respect, except that the radical of the acid of one series is phosphorus, and that of the other arsenic. If we add phosphoric or arsenic acid, to carbonate of soda, till the solution shews a neutral re-action, we obtain no crystalline salt; but if we add carbonate of soda in excess, we procure large and beautiful crystals, in which the oxygen of the base is to that of the acid as 2 to 5. The neutral combinations of arsenic and phosphoric acid with potash, and the double combinations of the same acids with potash and soda, are equally uncrystallizable, unless they have an excess of base. The arseniate and the phosphate of ammonia crystallize only with an excess of base, as well as the double salts which they form with the arseniate and the

* All this we cannot but regard as mere *hypothesis*.

phosphate of soda. Berzelius calls the salts which are in this degree of saturation, *neutral* phosphates and arseniates, a denomination retained by M. Mitscherlich. If we precipitate a solution of muriate of barytes by a phosphate or arseniate, taking care to add the solution drop by drop, the liquor which remains after the complete precipitation of the acid shews then a neutral re-action, and yields no cloud with ammonia. The arseniate and the phosphate of barytes which have been precipitated are, by analysis, found to be in the same degree of saturation as the above-mentioned salts. The oxide of lead comports itself in the same way as barytes.

If we add to the above salts as much acid as they previously contained, we obtain bi-phosphates, and bin-arseniates of potash, soda, and ammonia, in which the oxygen of the base is to the oxygen of the acid as 1 to 5. On adding to a solution of a neutral salt, with base of barytes, these bi-phosphates or bin-arseniates, no precipitate takes place; for the bi-phosphate and bin-arseniate of barytes are soluble in water. We obtain these two salts, if we dissolve the neutral arseniate or phosphate of barytes in phosphoric or arsenic acid, and set the solution to crystallize. The bi-phosphates contain, according to Berzelius, exactly a double quantity of acid to that in the neutral salt.

If we precipitate the solution of a neutral salt, having for base lime, zinc, copper, silver, mercury, or several other oxides, by a neutral arseniate or phosphate, the liquor shews, after the precipitation, a very acid re-action, and we must add much ammonia to neutralize it. The oxygen of the base is to that of the acid in these precipitated salts as 3 to 5. A solution of a neutral arseniate or phosphate shews always alkaline to the usual tests. To a solution of an arseniate and phosphate of soda, in known quantity, sulphuric acid was added, till the solution appeared to be neutral; a point, however, very difficult to hit, for if litmus paper shew an acid predominance, that stained with turmeric or rhubarb indicates excess of alkali. After adding to this liquor much muriatic acid, it was precipitated by muriate of barytes; and from the sulphate of this earth which was obtained, the quantity of sulphuric acid employed to render the solution neutral, was computed. It thus appeared that the acid added to neutralize a solution of a crystallized phosphate or arseniate, saturates the third of the base.

If we add to a phosphate or arseniate, phosphoric, or arsenic acid, as long as it shews a neutral re-action, and if we precipitate muriate of barytes, by this solution, we obtain a precipitate which is a neutral salt, with base of barytes; but the solution shews powerfully acid to tests, and yields, when treated with ammonia, an abundant precipitate, because a bi-phosphate or bin-arseniate of barytes was formed. The degree of saturation

in the crystallized arseniates or phosphates is consequently different from that in which they exist dissolved in water. If the arseniate and phosphate of soda crystallize in a solution which already appears alkaline to re-agents, the liquor, after the crystallization, is manifestly acid. If, on the contrary, the base of the crystallizing salt is potash, the liquor shews a highly alkaline state. In the first case, the salt which crystallizes is a neutral salt; in the second, it is an acid salt. If we moisten litmus paper with the solution of bi-phosphate or bin-arseniate of potash, the paper becomes red; but on drying, the blue colour returns, for the salt resumes, on crystallizing, the quantity of acid which had reddened the test paper.

It is, in general, very easy to determine the degree of saturation of an arseniate or phosphate. The neutral salts precipitate the muriate of barytes, so that the liquor shews a neutral reaction, and a neutral salt is precipitated. It is, however, to be remarked, that the neutral arseniate and phosphate of barytes are, in a very slight degree, soluble in water, and that we ought never to precipitate the arseniates or phosphates by muriate of barytes, because that then the excess of the base, which is free in the solution, would convert the neutral phosphate and arseniate of barytes into a a subsalt; and hence, for the same reason, we ought to add the arseniate or phosphate only drop by drop to the muriate of barytes. The neutral solutions of oxide of lead comport themselves in the same manner with the neutral phosphates and arseniates. The bin-arseniates and bi-phosphates do not precipitate the solutions of muriate of barytes; but on adding the smallest quantity of ammonia, or of any other soluble base, we obtain a precipitate. Another very ready mode of ascertaining the degree of saturation of the phosphates and arseniates, with base of soda and potash, is to heat them to redness with the carbonate of potash or soda. They expel carbonic acid till a subsalt is formed, in which subsalt the oxygen of the base is to that of the acid as 1 to $1\frac{2}{3}$; and from the loss of carbonic acid we calculate the quantity of arsenic or phosphoric acid which the salt contains.

A perfectly exact analysis of the phosphates and arseniates, presents almost insurmountable difficulties.

Of the Bin-arseniate and Bi-phosphate of Potash.

The bin-arseniate of potash occurs in commerce in large crystals. It is manufactured in Saxony and other places, by fusing one part of nitre with one part of arsenious acid. The melted mass is dissolved in water, from which crystals are obtained, after evaporation. The best manner of preparing these two salts is to add carbonate of potash to phosphoric or arsenic acid, till litmus paper reddened by the solution, becomes blue

on being dried. The salts are purified by crystallization. 100 parts of this bin-arseniate, according to Berzelius, consist of,

Arsenic acid . . .	63.87
Potash	26.16
Water	9.97
	100.00

The bi-phosphate, according to the same chemist's atomic proportions, consists of phosphoric acid 25.26, potash 34.56, water 13.18. In these two salts, therefore, the relation of the oxygen of the base is to the oxygen in the acid as 1 to 5; and to that in the water as 1 to 2.

The acetate of lead decomposes completely the bin-arseniates and the bi-phosphates, for the arseniate and phosphate of lead are insoluble in acetic acid; the precipitate is commonly a neutral salt, but we can never be sure whether the neutral salt is not mixed with subsalt. The precipitation by the muriate of barytes is exposed to the same difficulties. The best method is to determine the base. After having precipitated the acid by the acetate of lead, and separated the salt of lead by the filter, we throw down the oxide of lead in the excess of acetate added, by carbonate of ammonia. We then evaporate the filtered solution, and after expelling the ammoniacal salt, and decomposing the acetate, we obtain the base, combined with carbonic acid. If we have employed muriate of barytes, we must precipitate the barytic excess with sulphuric acid, and not by carbonate of ammonia, because the carbonate of barytes is not completely insoluble in water. It is better, however, to make the analysis with the acetate of lead.

Of the Faces of the Crystals, and their reciprocal Situation.

We obtain sometimes the primitive figure, which is an octohedron, with a square base (Fig. 1.)*, from a solution which contains more potash than that of the bin-arseniates or the bi-phosphates. The ordinary form under which these salts are presented is a prism, with square bases, terminated by the faces of the octohedron, (Fig. 2.) M. Mitscherlich has never observed any other modifications. He has found by his measures the inclination of the plane *l*, to the plane *l'*, to be 90°, and that of the face *P*, to one of the facettes which are situated near it, equal to the inclination which it has to the other of these faces. It follows that the primitive form is an octohedron with a square base. He has found, by more than 30 measures, both in the bi-phosphate and in the bin-arseniate of potash, that the inclination of the plane P, on the plane which is situated on the other side of the axis, is from 93° 30′ to 93° 50′, usually from 93° 31′, to 93° 40′. The axes of the octohedron are nearly as 2 to 3.

* The figures belonging to this paper will be given, with its conclusion, in our next Number.

Angles of the Crystals.

P′ : P‴	. . .	=	86° 24′
P′ : P″	. . .	=	122° 16′
B′ : B returning	.		112° 50′
B′ : B″	. . .	=	67° 10′
P : *l*	. . .	=	133° 12′
l : *l*	. . . .	=	90°

Bi-phosphate and Bin-arseniate of Ammonia.

If we add arsenic or phosphoric acid to ammonia till litmus paper be strongly reddened by the solution, and till it no longer precipitates muriate of barytes, we obtain crystals which do not change on exposure to air. The muriate of barytes is not precipitated by these crystals, but the smallest quantity of ammonia produces a precipitation. They are consequently at the same degree of saturation as the bi-phosphate and bin-arseniate of potash and barytes; and they comport themselves, with solutions of metallic oxides, precisely as the bin-arseniate and the bi-phosphate of potash. These salts dissolve very well in water. Bin-arseniate and bi-phosphate of soda are not decomposed by a red heat. On mixing bin-arseniate and bi-phosphate of ammonia bruised, with the neutral phosphate of soda in excess, it is found, on heating the mixture, that the acid remains with the salt having soda for its base, and that the ammonia and the water are completely driven off. The bin-arseniate of ammonia consists, according to the atomic proportions of M. Berzelius, of

Arsenic acid	72.30	
Ammonia .	10.77	100.00
Water . .	16.93	

The bi-phosphate of ammonia is composed, by the same authority, of . . . .

Phosphoric acid	61.79
Ammonia . .	14.85
Water . . .	23.36
	100.00

We have here 3 proportions of water to 1 of ammonia.

Of the Faces of the Crystals, and their relative Situation.

The primitive form of these salts is an octohedron, with a square base; but it is very rarely met with. The form under which they usually occur is a prism with square bases terminated by the faces of the octohedron (Fig. 2. D′, P.) No other modification has been observed either in the phosphate or arseniate of ammonia, although a great number of crystals obtained from different solutions have been examined. The inclination of *l* upon *l* is by measurement 90°; and the inclination of the plane P upon one of the adjoining planes, is equal to that of P, on the other adjoining plane. The inclination of the plane P, on the plane P, situated on the other side of the axis,

was 89° 35′. The axes of the octohedron are consequently in the ratio of 1 to 1.404. If the edge B makes with B, situated on the other side of the axis, an angle of 109° 28′, this ratio is as 1 : $\sqrt{2}$.

Angles of the Crystals.

P : P′ = 89° 35′;
P′ : P‴ = 90° 25′;
P′ : P″ = 119° 46′;
B : B′ = 109° 4′;
B′ : B″ = 70° 52′;
l : *l*″ = 90°
l : P = 135° 12′½

Of the Arseniate and Phosphate of Ammonia.

We obtain these salts by adding ammonia to concentrated arsenic or phosphoric acid, till a precipitate be formed. On heating the liquid, the precipitate is dissolved. If we then leave the solution to itself, preventing too much of the ammonia from flying off, there are formed, after a certain time, large and beautiful crystals of neutral salt. It happens sometimes, however, that crystals fall down during the cooling of the solution, which are a subsalt with basis of ammonia, which were not examined because they change instantly on exposure to the air.

The crystals of the neutral salts are decomposed in the air. They are more soluble in water than the crystals of the bin-arseniate and bi-phosphate of ammonia. The solution of these crystals precipitates the muriate of barytes, so that the liquor exhibits a neutral re-action. On analyzing the precipitated barytic salts, they were found to be neutral. Hence the ammoniacal arseniate and phosphate were neutral also. Without paying attention to the crystalline form, it is impossible to make an analysis of the salts with base of ammonia, both acid and neutral; for on making a solution crystallize, we always obtain a mixture of the acid and neutral salt. By processes analogous to those previously described, the acid, and the sum of the ammonia and water contained in the salt were determined.

100 parts of arsenic acid combine with 29.804 parts of ammonia, and consequently with 24.345 of water, to form the neutral salt. It contains 1½ proportion of water, and consists, by the atomic determination of Berzelius, of

Arsenic acid . .	65.28	
Ammonia . . .	19.44	100.
Water	15.28	

100 parts of phosphoric acid, combine in forming the neutral phosphate of ammonia, with 48.06 parts of ammonia, and consequently, with 35.675 parts of water. The neutral phosphate of ammonia contains therefore 1½ proportion water, and consists, according to Berzelius, of

Phosphoric acid . .	53.80	100.
Ammonia	25.86	
Water	20.34	

Of the Faces of the Crystals, and of their relative Situation.

The primitive form of the crystals of these two salts, is an oblique prism with rhombic bases (Fig. 5 and 6). The mean of a great many measures gave for the inclination of the plane M′ on the plane M″, in the arseniate of ammonia 85° 54′, and in the phosphate of ammonia 84° 30′. The plane *f* replaces the solid angle A, and forms with P an edge parallel to the oblique diagonal of the plane. The inclination of *f* to P was, in the arseniate of ammonia, 109° 8′; in the phosphate 109° 44′. It was found on measuring also the inclination of P to M, that the cotangent of the angle, which P makes with the axis is in the two salts, to that of the angle which *f* makes with the axis in the ratio of 1 to 2½. From these data M. M. deduced, that P makes with the axis an angle of 66° 29½′ in the arseniate of ammonia; and an angle of 66° 45′ in the phosphate.

On the Neutral Arseniate and Phosphate of Soda.

We obtain these two salts, if we add carbonate of soda to arsenic or phosphoric acid, till the solution appear alkaline by test paper. As they are much more soluble in hot than in cold water, they crystallize readily from a concentrated solution. These salts precipitate the muriate of barytes so that the solution remains neutral; and the muriate of lime, so that the solution exhibits a very acid re-action. They are consequently in the same degree of saturation as the neutral arseniate and phosphate of barytes. 100 parts of arseniate of soda are composed of

Arsenic Acid .	65.84
Soda	34.16

The arseniate of soda, the base of which contains 2½ times the oxygen present in the acid, is consequently, according to the atomic weights of Berzelius, a compound of

Arsenic Acid .	64.82
Soda	35.18

100 parts of the dry salt unite with 126.3 of water; whence the oxygen of the base is to that of the water as 1 to 12. It thence follows that 100 parts of the crystals consist, by Berzelius, of

Arsenic Acid .	29.29
Soda	15.88
Water . . .	54.84*

4.387 grains of phosphate of soda, which did not contain a trace of sulphate of soda, added to muriate of barytes, gave

* M. Mitscherlich remarks here, that Dr. Thomson must have confounded the neutral salt with the bin-arseniate in his analysis.

7.260 grains of phosphate of barytes. The liquid shewed a perfectly neutral re-action, and was not precipitated by ammonia.

The 7.260 grains of phosphate of barytes contain 2.309 grs. of phosphoric acid; whence the phosphate of soda is, by this analysis, composed, in 100 parts, of

Phosphoric acid .	52.63
Soda	47.37

According to the analysis of Berzelius, this salt contains,

Phosphoric acid .	53.48
Soda	46.52

and by his atomic determination it consists of

Phosphoric acid .	53.30
Soda	46.7

The oxygen of the base is to that of the water in the ratio of 1 to 12, by Berzelius. In the crystallized phosphate of soda, the oxygen of the base being to the oxygen of the acid as 1 to 2½, and to the oxygen of the water as 1 to 12; the salt ought therefore to consist, according to Berzelius's atomic numbers, of

Phosphoric acid .	20.31
Soda	17.80
Water	61.89
	100.00

Of the Faces of the Crystals, and of their relative Situation.

The primitive form of these two salts, is an oblique prism with rhombic bases, (Fig. 7). It is found usually with the faces *f* and *t*, (Fig. 8 and 9). The plane M′ makes with M′ an angle of 67° 50′. The inclination of *f* to P was 129° 12′; and the inclination of P to the axis is consequently 58° 30′; and that of *f* to the axis 70° 42′ *.

II. Caloric.

M. Poisson read before the Academy of Sciences, on the 31st December, 1821, a memoir on the distribution of heat in solid bodies, of which an extract is given in the *Annales de Chim. et de Phys.* for April, 1822. He divides the subject into two parts; the formation of differential equations of the movement of heat, whether in the interior or on the surface of solid bodies; and, secondly, the complete resolution of these equations, to deduce from them, at any instant whatever, the temperatures of all the points of the body under consideration, according to that which they possessed at a determinate epoch. As far as we can judge from the extract made by the author himself, this memoir seems rather a display of his mathematical resources, than a contribution to physical knowledge.

* The remaining abstract of this memoir, is reserved for the next Number.

M. M. Gay-Lussac and Welter are occupied at present with the heat disengaged by the gases, when their volume is made to vary under very different pressures. They have already obtained several results, which they propose to submit to the Academy of Sciences, when their labour shall be more complete; but meanwhile they have thought it right to communicate a fact which appears to them very singular.

It is known that when we dilate air, or any other elastic fluid, by enlarging the space in which it is enclosed, cold is produced. The fact observed by these gentlemen is announced in the following proposition: "The air which escapes from a vessel in blowing through an aperture, under any pressure whatever, does not change the temperature, although the air is dilated in issuing from the vessel."

It would seem to result from this, that there is heat produced in the blowing of the air, and that this heat is as much more considerable as the difference of pressure which produces the blast is greater; so that the heating compensates exactly the cold produced by the dilatation. This fact would explain why heat is produced when air enters into a void space, or one occupied by air at a smaller pressure. It would explain also why the blast of the machine with the column of water at Schemnitz produces cold and congeals water; whilst the blast of the reservoir of air of the steam-engine at Caillot, where the pressure is constant, and of 2.6 atmospheres, does not affect the thermometer. We shall be happy to see the memoir of these two ingenious chemists in detail; and shall abstain meanwhile from any remarks on the obscurity of one of the above statements.

On the Temperature of the Interior of the Globe.

Mr. Fox, in reply to Mr. Moyle, who had ascribed the elevated temperature of mines to the presence of workmen, states that at the mine of Treskerby, which is 840 feet deep, the temperature, two days after the departure of the workmen, was 75.2° F., the same as during their presence. The water, which flows in abundance at the bottom of the mine, marked precisely the same degree. A thermometer, sunk some inches in the ground, at the bottom of the deepest gallery of the mine of Dolcoath, at 230 fathoms from the surface, has always marked, during eight months continuously, 75.5° F. In all this time the workmen were employed at a great distance from the place where the thermometer was stationed. We have no faith in these speculations concerning the elevated temperature of the lowest strata of the earth's surface, and are inclined to adopt Mr. Moyle's explanation until in possession of *much more decided evidence* than any that Mr. Fox has adduced.

III. Inorganic Chemistry.

i. *On the Chemical Composition of the white efflorescing Pyrites, by* M. Berzelius*.

It is known that the crystalline form of the white pyrites differs so essentially from that of the yellow pyrites, that M. Haüy thought he ought to separate them, as two different mineral species. Yet chemical analysis finds no difference of composition between these two substances, which appear to add one example more to the exceptions to the general rule, which are furnished by the differences between the two forms of carbonate of lime, and that more lately observed by M. Mitscherlich, in the two forms of the super-phosphate of soda.

White pyrites presents two varieties, one of which perfectly crystallized does not change in the air; while the other, which exhibits a confused crystallization, effloresces on exposure to air, and falls into a powder evidently vitriolic. This phenomenon, therefore, proves a difference of composition between these two varieties; a difference deserving of being studied, in order to learn if it be such, as might explain to us their differences from yellow pyrites.

M. Berzelius left a piece of white pyrites to effloresce for two years and a half; and when it was entirely disintegrated, he undertook its examination. Its volume was nearly doubled; it was split in every direction, and fell into fragments on the slightest touch. A part of its mass was converted into a white powder, of a styptic taste, and this powder was beginning to turn yellow on the extreme points. Viewed under a microscope, it presented a mass full of small clefts, filled with a white efflorescing salt, the interstices of which appeared to be white pyrites, untouched and more or less crystalline.

He treated a certain portion of it with water; separating the solution from the insoluble residuum. The latter consisted partly of a coarse powder, which was composed of small grains of pyrites, and partly of a powder, which was finer, lighter, and of a grayish or almost black colour. When viewed under the microscope, this powder presented merely brilliant particles of pyrites, without any trace of sulphur evolved and mingled with the pyrites.

(*a*) The solution deposited, on contact of air, a yellow ochre; it was therefore entirely neutral. He treated this solution, with nitric acid, to oxidize the iron to a *maximum*, and he then decomposed it by means of muriate of barytes and caustic ammonia. It yielded 2.03 grains of sulphate of barytes; and after the separation of the excess of the muriate of barytes by sulphuric acid, 0.68 grains of peroxide of iron. The weights are

* *Annales de Chim. et de Phys.*, May, 1822.

precisely those which the neutral sulphate of the protoxide of iron ought to have given ($\ddot{\mathrm{Fe}}\ \dddot{\mathrm{S}}^{2}$); for

29.16 : 9.78 :: 2.03 : 6.809.

The salt formed was equivalent to 0.74 grains of proto-sulphuret of iron ($\mathrm{Fe\,S^2}$); but the undecomposed residuum of pyrites weighed 4.653 grains, that is to say, 6 and 7 times as much as the effloresced portion *.

(*b*) To satisfy himself that the insoluble residuum contained no free sulphur, he dissolved a portion of the most finely divided part in nitro-muriatic acid, till the sulphur was entirely acidified. There remained a little undissolved silica. The solution afforded 0.64 grains of oxide of iron, and 3.82 grains of sulphate of barytes, which is in perfect accordance with the composition of deuto-sulphuret of iron; that is, with pyrites. Now since the effloresced portion was a sulphate with a base of protoxide, containing no acid in excess, and since there were no traces of sulphur separated during the efflorescence, it is evident that the effloresced portion was a proto-sulphuret of iron ($\mathrm{Fe\,S^2}$), which has not been hitherto found in an insulated state in the mineral kingdom †; and that the remainder which was not subject to effloresce, was a deuto-sulphuret ($\mathrm{Fe\,S^4}$).

The efflorescing pyrites can be, therefore, nothing else but particles more or less completely crystallized of $\mathrm{Fe\,S^4}$, cemented together by particles much less numerous of $\mathrm{Fe\,S^2}$, which are converted by degrees, at the expense of the air and its humidity, into $\ddot{\mathrm{Fe}}\ \dddot{\mathrm{S}}^{2}$: pyrites loses thus its coherence, in proportion as the crystallized particles are destroyed. The efflorescence contributes in no respect, therefore, to the solution of the question of the diversity of the forms of yellow and white pyrites.

On the Composition of the Alkaline Sulphurets. By M. Berzelius.

The first question to be resolved is, if the sulphur can combine directly with an oxidized body; or, if there be then formed a sulphate and a metallic sulphuret, as M. Vauquelin has presumed.

I. *Experiments to determine if the Hepar formed in the dry way is a sulphuret of an oxide, or of a metal.*

1. It is clear, that if a sulphuret of potash can exist, it ought to be formed, for example, when we reduce sulphate of potash, and that after the solution in water of the compound reduced, the result ought to be entirely different, if it is sulphuret of potash, or of potassium. To verify this fact, he made use of a

* C'est à dire six et sept fois autant que la partie effleurie.—*Annales*, xix. p. 442.

† Magnetic pyrites, which does not effloresce, is a chemical combination of $\mathrm{Fe\,S^4} + 6\ \mathrm{Fe\,S^2}$.

small apparatus blown at the enameller's lamp, and constructed so that he could pass through it a stream of hydrogen gas, while one part of the apparatus was heated to redness by an Argand lamp with spirit of wine. Into this part was introduced 1 grain of neutral sulphate of potash. This salt experienced for some time no alteration; but when the heat became more intense, there were perceived red points, which extended quickly, and water began to be formed. Soon the substance became black, and entered into fusion. The operation was continued as long as the gas introduced seemed to produce water, which was condensed over muriate of lime. The salt, when cool, presented a mass of a very fine cinnabar-red; and the glass had been visibly acted on. This compound had lost 0.315 grains, and the water which was formed weighed 0.335 grains. The red mass was easily dissolved in water, which assumed a hue very faintly yellowish. There was deposited some silica, proceeding from the glass, and muriatic acid disengaged sulphuretted hydrogen with effervescence; at the same time the liquid seemed slightly clouded with a little sulphur. Decomposed by muriatic acid, it afforded with muriate of barytes 0.157 grains of barytes (sulphate of barytes), corresponding to a portion of 0.108 grains of sulphate of potash. The 0.335 grains of water produced contain 0.298 of oxygen; but the sulphuric acid in 1 grain of sulphate of potash, contains only 0.275, and the potash only 0.092 grains of oxygen. Now if we consider that there remained at the end of the experiment $\frac{1}{10}$ of the salt which appeared not to have been decomposed, we shall find that about $\frac{3}{4}$ of the potash had been reduced into potassium, and that the remaining $\frac{1}{4}$ had combined with the glass on losing its sulphur, a portion of which united to the potassium, and the other accompanied the hydrogen under the form of a white vapour, which caused the excess of the loss of salt beyond what was found in the oxygen of the water,

2. This experiment would already prove that the hepar contains sulphuret of potassium, since, were the combination of sulphur with potash possible, hydrogen gas could not certainly reduce this alkali at so moderate a heat; but the loss which the glass had suffered, throwing some uncertainty on the result of this experiment, M. Berzelius made choice of another means. He reduced, in an apparatus perfectly similar, sulphate of potash by sulphuretted hydrogen, and continued the operation as long as water escaped with the gas, which continued for 3 hours; at the same time there was deposited some sulphur; but as soon as no more water is formed, the sulphur separates no longer from the gas. He let the operation go on for a quarter of an hour after the last period.

One grain of sulphate of potash was converted in this manner into 1.11 grains of hepar. Very liquid and black while it

was hot, it became on cooling, altogether transparent, and of a wine red colour. It was readily dissolved in water; the liquid was limpid and yellow. This solution was decomposed in a suitable apparatus, by muriatic acid, which precipitated from it a white powder without producing any disengagement of gas. The liquor was heated to ebullition, and a gas was developed which was collected in a solution of acetate of lead. After a moment of ebullition, there was passed through the liquid a stream of atmospheric air, to expel the last portions of sulphuretted hydrogen. By this means, there was obtained in the solution of the lead, a sulphuret of this metal, which after being washed, dried, and heated in vacuo, to separate the whole moisture, weighed 1.407 grains, containing 0.189 of sulphur; but the quantity of sulphuretted hydrogen which would be disengaged, if in 1 grain of sulphate of potash the whole alkali were reduced into potassium, ought to contain 0.184 grains of sulphur. This difference can proceed only from some error of observation. The sulphur precipitated by the muriatic acid, having been washed and dried, weighed 0.488 grains, and being melted, lost nothing of its weight. After this precipitation, the liquid, mingled with muriate of barytes, afforded no sulphate of barytes. One grain of sulphate of potash contains 0.449 grains of potassium. Now supposing that sulphuret of potassium is formed, the result of this experiment is,

Potassium	44.9
Sulphur (precipitated)	48.8
Sulphur (in the sulphuretted hydrogen)	18.4
	112.1

that is to say, 0.011 grains more than the dissolved hepar weighed, which is derived undoubtedly from some error in the analysis. The hepar obtained was then a sulphuret of potassium; but it is difficult to determine what was its degree of sulphuration. The sulphuretted hydrogen having given up sulphur during the formation of the hepar, this circumstance would seem to indicate a combination made in determinate proportions, which did not permit it to retain the whole of the sulphur. In this case, it would be KS^7, and 1 grain of sulphate of potash ought to weigh 1.093 after its decomposition by sulphuretted hydrogen. If the gas had deposited all its sulphur, the combination would have been KS^{10}. It appears then, that in this operation, there escapes 3 atoms of sulphur with the gaseous bodies; but the different degrees of sulphuration of potassium will be considered further on.

3. The same experiment was repeated, with this difference, that vapours of the sulphuret of carbon were passed over the sulphate of potash. One grain of this salt afforded 1.22 grains of sulphuret of potassium, which decomposed in the manner above stated, produced:

Potassium	44.9
Sulphur (precipitated)	58.1
Sulphur (of the sulphuretted hydrogen) .	18.4
	121.4

The liquor, precipitated by muriatic acid, contained here no trace of sulphuric acid. The sulphuret of potassium obtained approaches to KS^8 (although the combination resulting from the total decomposition of the sulphate of potash by the sulphuret of carbon ought to be as in the preceding experiment KS^{10}.) It ought therefore to have weighed 119, instead of 122. Thus the actual result exceeds the 8 atoms by the same quantity, that the preceding result exceeded 7 atoms. These experiments prove then in a peremptory manner, *that the hepar obtained was sulphuret of potassium in different degrees of sulphuration, and that through the agency of the sulphur, a very feeble heat is sufficient to reduce, by hydrogen or carbon, potash into potassium.* The glass had not been attacked in any one of these experiments.

4.—5 grains of pure lime (free from water and carbonic acid), were introduced into a weighed tube of porcelain, and exposed to a stream of sulphuretted hydrogen. As soon as all the atmospheric air had been expelled, the tube was heated to redness, at the place where the lime was situated. Aqueous vapours appeared, which were condensed on muriate of lime. The operation was continued, as long as it could be perceived that water escaped along with the gas; the tube was then suffered to cool, at the same time that the stream of sulphuretted hydrogen was passed through it. 1.57 grains of water were obtained; and there remained in the tube 6.41 grains. These are, within a mere trifle, the weights which ought to result from the transformation of the lime into a sulphuret of calcium, and from the combination of the oxygen of the lime with the hydrogen of the gas. The compound was dissolved in muriatic acid, with disengagement of sulphuretted hydrogen gas; and muriate of barytes poured into the solution produced in it no precipitate. These experiments made with an alkaline earth, and an alkali, prove then in a decisive manner, *that the compounds hitherto regarded as alkaline or earthy sulphurets, are combinations of sulphur with the metallic radical of the alkali or the earth.*

Since hydrogen reduces sulphate of potash, with the production of water which evaporates, it is clear that at an elevated temperature, sulphur may also reduce the potash into sulphuret of potassium, and that there ought to be formed at the same time, sulphate of potash; which fully confirms the opinion of M. Vauquelin, in regard to what happens when the sub-carbonate of potash is melted with sulphur. This celebrated chemist relates, in his experiments on the combinations of sulphur with the alkalis, that when the potash is united with the sulphur by fusion, there is formed a quantity of sulphuric acid, the oxygen

of which is equal to that of the potash; it being understood, that we must deduct from the calculation, the quantity of oxygen which is present in the potash, combined with sulphuric acid; but this last forms $\frac{1}{4}$ of the whole quantity of potash; so that the oxygen of the sulphuric acid can constitute only $\frac{3}{4}$ of that which is found in the entire potash. To verify this fact, M. Berzelius prepared hepar with 1 grain of carbonate of potash, which was fused in a small retort with $1\frac{1}{8}$ times its weight of sulphur*.

The mixture was dissolved in boiling water, and precipitated by muriate of barytes, whence there resulted in two experiments, 0.421 grains of sulphate of barytes. From calculation, 100 parts of sub-carbonate of potash transformed in this manner into hepar, ought to afford 42.15 parts of sulphate of barytes. These experiments then prove, that *when the sub-carbonate of potash is fused with sulphur, $\frac{1}{4}$ of the potash serves to form sulphate of potash, and the other $\frac{3}{4}$ are converted into sulphuret of potassium*; a theorem, which we ought henceforth to employ in several calculations, and whose justness it was right to establish by experiment, although it was easy to infer it *à priori.*

II. *Experiments on the different Proportions in which Potassium can combine with Sulphur and with sulphuretted Hydrogen.*

1. When sulphate of potash is reduced by hydrogen or carbon, there is formed the first degree of sulphuration of potassium, that is to say, KS^2, which is proportional to the sulphate. It is difficult to obtain it pure. If the operation be made in glass, it is attacked; if in *platinum,* there is formed a higher sulphuret, which is mingled with potassuret of platinum. Prepared in glass, the sulphuret has a beautiful colour of pale cinnabar, and a crystalline fracture. It becomes dark-coloured when we heat it; it fuses before it comes to a red heat, and then it is black and opaque. When heated in *the open air,* it does not take fire; it is difficult to roast; but it becomes incandescent at the place where it has been kindled. It is extinguished the moment that it becomes covered with sulphate of potash. All the properties of sulphuret of potassium demonstrate sufficiently, that it is a mistake to ascribe the ignition of pyrophorus to the presence of the sulphuret of potassium, which certainly has not this virtue, if it be not united to a more combustible body. It attracts humidity from the air, and is resolved into a yellow liquid, which on dilution with water, becomes colourless. It is completely soluble in alcohol. Placed in contact with water or alcohol, it does not become hot; which proves that the affinities that act in the solution are not very strong.

To find what is the *maximum* of sulphur which can combine

* The carbonate of potash was prepared out of contact of air, by calcining the bi-carbonate in a retort. After weighing, the sulphur was added; and before applying heat a stream of carbonic acid was passed through, to expel the atmospheric air.

with potassium, M. Berzelius fused in a small retort 0.782 grains of carbonate of potash with 1.5 grains of sulphur, and the mixture was exposed to a moderate heat until the excess of sulphur was driven off. It weighed then 1.267 gr. To the upper part of the retort there was attached a small portion of hepar of a livelier red, which, on solution in water, deposited sulphur. It was, however, in so small quantity, that its weight was not ascertained. The salt employed contained 0.5326 grains of potash, of which $\frac{1}{4}$=0.13315 had formed sulphate of potash=0.0458 grains of sulphur, and with the oxygen of the other $\frac{3}{4}$. To find the quantity of sulphur that was combined with the reduced potassium, we must deduct from 1.267, the weight of the potash, and that of the sulphur in the sulphuric acid, together = 0.5784. This quantity is 0.6886, which was united to 0.3315 grains of potassium; that is to say, 100 parts of potassium had taken 207.7 parts of sulphur; but this number constitutes nearly 10 atoms; for the weight of K : 10 S :: 100 : 205.2.

Hence, 100 parts of sub-carbonate of potash absorb at a *maximum* 93.9 of sulphur. The brighter colour of the hepar which was deposited on the upper part of the retort, and which, on solution, gave up sulphur, led to the belief that there existed a sulphuret of a still higher degree, which could not exist at a red heat, and which water also decomposed in separating a portion of its sulphur. But experiment shewed it to be merely a mixture of hepar and sulphur.

3. It has already been observed, that when the sulphate of potash is decomposed, at a high temperature, by sulphuretted hydrogen gas, there results a bright hepar, entirely transparent, and of an orange red, which seems to be KS^7; and when the same salt is decomposed by sulphuret of carbon, then is formed KS^8. The latter is not transparent, and its colour is less beautiful than that of the preceding. There is observed almost always in these operations, the same proportion of sulphur in excess.

4. By varying the proportions, M. Berzelius obtained sulphurets which he regards as compounds of 2, 4, 6, 7, 8, 9, and 10 atoms of sulphur with 1 of potassium.

1. KS^2 is obtained by reducing sulphate of potash, by means of hydrogen.

2. KS^4 by fusing carbonate of potash at a red heat, with a quantity of sulphur less than is necessary to decompose it.

3. KS^6; by heating slowly the said mixture, till it melts without ebullition or the disengagement of any gas whatever.

4. KS^7; by reducing the sulphate of potash, with sulphuretted hydrogen gas.

5. KS^8; by keeping in fusion the hepar at the *maximum* $(\ddot{K}S^2 + 3KS^{10})$ in sulphuretted hydrogen gas, till no more of either water of sulphur be disengaged; or otherwise, by reducing sulphate of potash, by sulphuret of carbon.

6. KS^9; by the fusion of the preceding with sulphur, whose excess is driven off by a moderate heat, whilst we pass over the melted mass a stream of sulphuretted hydrogen, or any other non-oxydizing gas.

7. KS^{10}; by the fusion of carbonate of potash with an excess of sulphur, till no more carbonic acid be disengaged. It is not necessary to raise the temperature to ignition, in order that the salt be completely decomposed. There is then formed $\ddot{K}\dddot{S}^2 + 3\,KS^{10}$.

The combinations where the sum of the atoms of sulphur is expressed by the even numbers, correspond to 1, 2, 3, 4 and 5 atoms of sulphur for the atom of potassium; potash being regarded as composed of an atom of radical and an atom of oxygen. These combinations harmonize with the two manners of counting the atoms; and the methods of obtaining them are such that they must produce combinations in determinate proportions.

As to those where 1 atom of potassium is united to 7 or 9 atoms of sulphur, they prove incontestably, says M. Berzelius, the justness of the opinion, that potash contains not one but two atoms of oxygen, considering that, in the first case, these combinations would contain $3\frac{1}{2}$ and $4\frac{1}{2}$ atoms of sulphur, and that we cannot admit half atoms. He is, however far from regarding the thing as proved by these compounds, especially since we know, that sulphuret of iron, for example, whether artificial or natural, is a combination of two degrees of sulphuration, as also that magnetic iron is composed of two different oxides of iron; and it would consequently be possible, that the said combinations might contain two degrees of sulphuration which would be either altogether similar in composition to the simple KS^7 and KS^9, or at least which would approach closely to them*.

III. *Combinations of sulphuretted Hydrogen with Potash.*

M. Berzelius has already shewn that the sub-carbonate of potash, decomposed by sulphuretted hydrogen gas, gives a hepar of a very bright yellow, which crystallizes on cooling, and which has a crystalline fracture like the salts. 20.87 grains of sub-carbonate, heated to a dull red, were exposed to a stream of sulphuretted hydrogen gas, as long as water was formed; and afterwards, while the apparatus was cooling. The compound was of a pale lemon yellow colour, and crystalline; presenting large brilliant plates. It weighed 22.28 grains. It was very deliquescent, and dissolved in water, to which it communicated a pale yellow colour.

20.87 grains of carbonate of potash contain 11.816 grains of

* We here present M. Berzelius's views in his own words. They seem neither clear, nor consistent, and we here enter our protest against the whole system of reasoning founded upon them.

potassium, a quantity which is consequently present in the 22.28 grains of sulphuret of potassium obtained. It was therefore united in it, with 10.464 grains of sulphur; but

$$11.816 : 10.464 :: 100 : 88.55.$$

Four atoms of sulphur would make 82.12. There is here the notable difference 6.43. He at first took this combination for that of KS^4; but having mixed a part of the solution with nitrate of copper, there formed to his great surprise a precipitate of sulphuret of copper, with the disengagement of sulphuretted hydrogen gas. Other metallic salts produced the same effect; consequently, the solution contained more sulphuretted hydrogen, than had been formed by the oxidation of the potassium. Mingled with an acid, it became cloudy indeed, and assumed a milky aspect; but when the sulphur fell, it was seen to be only a very slight deposit; and the remainder of this substance escaped in the form of sulphuretted hydrogen gas. It was clear, therefore, that the combination effected in the dry way, was composed of sulphuret of potassium, and sulphuretted hydrogen; now, if we suppose that it was a double sulphuret, $KS^2 + 2K^2S$*, that is to say, that the potash and hydrogen, were united to an equal quantity of sulphur, 100 parts of potassium ought to have combined with 82.12 parts of sulphur, and 2.60 of hydrogen, together = 84.72 parts. The excess actually found is undoubtedly due to the contact of air, which, in oxidizing the hydrogen at its expense, has formed a higher degree of sulphuration, whence has proceeded the precipitate produced by the acids.

It was interesting then to know if the neutral hydrosulphuret of potash is a compound of the same kind. With this view M. Berzelius saturated a portion of pure potash with sulphuretted hydrogen gas, and raised the mixture to ebullition; passing at the same time through the apparatus a stream of hydrogen, till the whole excess of the sulphuretted hydrogen had been expelled. A portion of this solution was precipitated by the muriate of copper, added drop by drop. The precipitate collected on a filter, well washed, dried and heated in a retort, till nothing remained but sulphuret of copper at the *minimum*, weighed 1.82 grains. The solution, after the remainder of the copper had been separated by the sulphuretted hydrogen, was evaporated to dryness, and afforded 1.71 grain of muriate of potash; there was therefore 2 atoms of copper for 1 of potash. We thence see, that in order to form a neutral hydrosulphuret, the potash takes a quantity of sulphuretted hydrogen, in which the hydrogen is double the quantity necessary to form water with the oxygen of the potash; and that this hydrosulphuret, in the dry state, may be represented like the preceding combination, by $KS^2 + 2H^2S$.

* Misprinted in the *Annales*. It ought to be $2H^2S$.

IV. Organic Compounds.

New Researches on Strychnine, and on the Processes employed for its Extraction. By MM. Pelletier and Caventou*.

Twelve pounds of grated nux vomica were exhausted by alcohol, and the tinctures were evaporated on a water-bath. The alcoholic extract acted on by water, left a notable quantity of a fatty matter. The filtered liquid was separated into 3 portions, of which the first represented 6 pounds of nux vomica, and each of the other two 3 pounds. These 3 portions were treated by a different method, the first of which may be called the process by magnesia; the second, the process by lead and sulphuric acid; the third, the process by lead and sulphuretted hydrogen. We shall describe them in succession.

1st. *Process by Magnesia.*—The liquor corresponding to six pounds of nux vomica was reduced to one-half by evaporation; three ounces of calcined magnesia were added to it, and, after some minutes of ebullition, it was filtered. The waters of filtration were left to themselves; we shall have occasion to return to them. The magnesian precipitate of a greenish-yellow colour was washed with *only two waters on the filter itself,* then dried at a stove In this state it was treated with alcohol at 38° (0.827,) in the cucurbit of an alembic; the alcoholic liquors proceeding from the *exhaustion* of the magnesian precipitate were filtered and evaporated to the consistence of a thick magma, which passed after some hours into a granular mass. The matter thrown on a filter was washed with a little very cold sulphuretted alcohol. Thus two drams and twelve grains of pretty fine strychnine were obtained. The mother-waters and alcoholic washings were set aside; we shall point out, further on, a method of extracting from them still a little strychnine.

The mother-waters of the magnesian precipitate, which were left to themselves, afforded, at the end of some days, crystals of a yellowish white, amounting to 80 grains. These crystals were strychnine, nearly pure. The same waters ought apparently to have furnished still more crystals. The method just described is very simple. The important point is the evaporation of the alcoholic digestions of the magnesian precipitate; this operation must be regulated so as to obtain the above magma, to let it granulate before washing it, and to employ for this edulcoration, very cold alcohol, at 22° (0.915.) Weaker spirits would not dissolve the colouring matter; stronger would carry off too much strychnine.

2. *Process by lead and sulphuric Acid.*—To a quantity of liquid, arising from the aqueous digestion of the alcoholic extract of nux vomica, and representing three pounds of this seed, sub-

* *Journal de Pharmacie.* Juillet, 1822.

acetate of lead was added, till all precipitation ceased. The filtered liquid contained an excess of acetate of lead. It was almost colourless and transparent. The lead was separated by sulphuric acid; then, the operation was finished by the decomposition of the sulphate of strychnine by means of magnesia, and the separation of the strychnine from the magnesian precipitate, took place as in the first process. The strychnine obtained weighed 48 grains.

The sulphate of strychnine might be also decomposed by ammonia, and the strychnine obtained by filtering the liquors. We shall insert here an observation, entirely new, which explains certain phenomena observed in the preparation of several vegetable alkalis. If the salt of strychnine be decomposed by concentrated ammonia, the heat produced is strong enough to melt the strychnine, which is then precipitated in the form of a pitchy matter, and remains long soft. This matter put for some time in contact with water, or left in the liquid that yielded it, absorbs water; the hydrate becomes then transparent and friable. In this state the strychnine is much less fusible.

Brucine presents the phenomena of *hydration* in a still more striking manner. One of the above gentlemen had prepared a sulphate of brucine, with brucine very much coloured. The sulphate was passed over animal charcoal, and then decomposed by very strong ammonia. The brucine precipitated in a fused and oily form; but at the end of two days it had increased considerably in volume, and had become a spongy and friable mass.

We shall also remark, in returning to strychnine, that this matter becomes hydrated with so much more difficulty, as it retains more colouring matter. The hydration takes place almost instantly when the strychnine is pure; it requires some hours, when the strychnine is a little coloured; but when it retains all its colouring matter, it takes days, and even weeks. This is the reason why a pitchy matter is always obtained, when an alkali is poured into a watery solution of the alkoholic extract of nux vomica; the absolute alcohol not being able to afford, or affording with great difficulty, water of hydration to the strychnine. When a fused and pitchy strychnine is to be re-dissolved in the menstruum, we ought to employ alcohol retaining a little water, that for example at 34° or 36° (0.847 or 0.837). The same precaution is not necessary, if the strychnine have been previously crystallized.

3. *Process by lead and sulphuretted Hydrogen.*—This is the process given in our first memoir, for the extraction of strychnine from nux vomica. It is that which has not succeeded with M. Robiquet, and the correctness of which he doubts. We have applied it also to a solution of nux vomica, representing three

pounds of this seed, and have redoubled our attention in the examination of the phenomena.

The colouring matter was first precipitated by subacetate of lead; the filtered liquid contained an excess of acetate of lead; a stream of sulphuretted hydrogen threw down the metal; the filtered liquid was concentrated to about one fourth of its volume, and then treated with pure magnesia. After some minutes of ebullition, the magnesian precipitate was separated by the filter, and after washing it with three waters, and drying it by the stove, it was subjected to the action of alcohol. The waters of the filtration and washings were set aside to be subsequently examined.

Alcohol digested on the magnesian precipitate is slightly coloured, and its taste becomes very bitter. Evaporated at the water bath, it gave a magma of a dirty white, which after becoming cold, was thrown upon a filter; then washed in the cold with a little weak alcohol. The matter was deprived of its colouring particles, and by desiccation in the air yielded a white powder weighing thirty-six grains.

This matter presented all the characters of strychnine, such as they had formerly described it. It had a very bitter taste. It was very soluble in alcohol, and crystallized in it. It was strongly reddened by concentrated nitric acid. It formed with the same acid diluted, a crystallizable salt, in pearly needles; and, finally, was so poisonous, that a grain was sufficient to kill a cat in five or six minutes. The authors have presented to the Section of Pharmacy a portion of this strychnine, which may be compared with the samples of strychnine procured by the two other processes.

Strychnine dissolves in hydro-cyanic acid, but by evaporation all the acid is disengaged, and the alkali remains pure.

In a postscript to the above memoir, the authors remark that subsequent experiments have led to some modifications of their statements; for example, the crystals obtained from the aqueous washings of the magnesian precipitate, of the first process, are not crystals of strychnine, but brucine; a substance which may be confounded with the other, without a scrupulous examination. The bean of Saint Ignatius, *Strychnos Ignatia,* contains also brucine, but in smaller proportion than the *Strychnos Nux Vomica.*

Art. XIV.—MISCELLANEOUS INTELLIGENCE.

I. Mechanical Science.

1. *On the Fabrication of Artificial Magnets.*—Professor Steinhäuser has ascertained, that if by the process of Canton, we unite, in the form of a square, two steel bars, and two contacts of iron, it is better to operate by the double touch in a circle, than by a motion backwards and forwards. Again, when we combine these bars in a square, the force of that which we wish to magnetize, ought to increase in proportion as the other magnet has become more energetic; that in magnetizing horse-shoe magnets, it is much more advantageous to place two of these bent bars, with their friendly poles so situated as that the magnetic circle be completed; and that we should then touch circularly, with the magnet destined to communicate the power. When the two horse-shoe bars are separated, they lose usually a considerable part of their force, if we do not previously decompose the great circuit into two smaller ones, by applying each contact to its curved magnet before the separation. In this way, the two separated magnets lose little or nothing of their power; and two may be touched in the same time that one is, on the usual plan. By conforming to these rules, Professor Steinhäuser has succeeded in making magnets of extraordinary power, in the least possible time. He also lays the bar to be magnetized on others previously made, and arranged in a horse-shoe form.

2. *Retrograde Movement of the Magnetic Needle.*—M. Arago, in commenting on Colonel Beaufoy's observations, inserted in the *Annals of Philosophy* for May, remarks that the numbers, given for its mean declinations in March, 1822, compared with those of March, 1819, give for the retrograde movement of the north point of the compass in three years—

By the observations of the morning	5′ 40″
By those of 1¼ hour after noon .	5′ 06″
And by those of the evening . .	6′ 32″
Mean . .	5′ 46″
Whence the mean annual retrogradation is	1′ 55″

More than 15,000 observations of the needle, made at Paris, by night and day, confirm this diminution of the declination.

3. *Comparison of British and French Canals, by M. Huerne de Pommeuse, Member of the Chamber of Deputies.*—This gentleman has just published a 4to volume on the above subject. "Vauban,"

says he, " after having laboured at 300 ancient strong holds, and constructed 30 new fortresses; after having conducted 55 sieges, and exposed his person in more than 100 battles, Vauban said to Louis XIV., in giving him an account of his inspection of the canal of Languedoc, with which the king had charged him, ' Sire, I would give all that I have done, and all that remains for me to do, to be the author of a work, so admirable and so useful to your kingdom.' In that country" (England), says M. de Pommeuse, " whatever is admitted to be truly useful, is not long in becoming the object of general emulation. The example set by the Duke of Bridgewater had soon numerous imitators; and since that epoch, the anxiety to make up for lost time has been such, that there exist at present in the British isles, 103 canals of navigation, the developement of which amounts to 2682 English miles (nearly 1000 leagues). One only of these canals (61 miles long) belongs to Ireland; five, which form together 150 miles in length, are excavated in Scotland; the others, to the number of 97, cover England alone as with a net-work, whose surface is not the quarter, and whose population is little more than the third, of that of France. This country possesses only six canals of grand navigation, the united lengths of which constitute only 150 leagues; and about 20 canals of secondary navigation, which have not altogether more than 100 leagues of developement."

The author does not scruple to acknowledge, that his principal object in the first half of the published volume, dedicated to the English labours, is to stimulate the emulation of his compatriots, and to make them co-operate with government in the existing circumstances, where France has much to create in this department. The editors of the *Bibliothèque Universelle*, in their account of this work, pleasantly observe, that the author's hope reminds them of a reply made to them in Tuscany, by a minister of state of great experience, to whom they extolled certain improvements elsewhere introduced, and which seemed to them capable of being imitated with advantage in his country: " Alas!" said he, " diseases communicate from people to people; but health, you know, is not contagious."

4. *Description of a Ductilimetre, or an Instrument for comparing the Ductility of different kinds of Lead, Tin, &c.*, described in the *Annales des Mines*, tom. vii.—This instrument is the contrivance of M. Regnier, and is said to furnish an useful means of trying different samples of lead and tin, more especially with a view of judging of their fitness for lamination. It consists of a mass of iron of a given weight, attached to the extremity of an iron lever, thirty inches long. (See Plate I.) The other end of this lever is moveable upon a transverse axis. When the hammer is elevated to a certain angle which may be measured upon

the quadrant of ninety degrees, it may be let fall upon the steel anvil which is attached to the small table upon which the whole is fixed.

In using this instrument, the different kinds of lead are cast into bullets of twenty-six to the pound, having a diameter of four-tenths of an inch; these are carefully smoothed and placed in the centre of the anvil, upon the surface of which are engraved several concentric circles; the hammer is then elevated to 50°, and let fall upon the ball under examination, which becomes flattened by the successive blows into a disc of 1.2 inches diameter. The number of blows given to each ball, in order to produce this extension, are counted. The following table shows the results of some of these trials:

	Samples.	Number of Blows.
1	Old sheet lead	12
2	New lead in pigs (W. Blackett)	11
3	Ditto (Blangill)	11
4	Ditto (Caldebek)	12
5	New sheet lead	12
6	Old lead of ten fusions	10
7	Cuttings of lead	12
8	Lead, with one-tenth of zinc	14
9	Tin	40

It appears that lead, ten times re-melted, instead of being injured, is improved in quality; that lead mixed with one-tenth of zinc is very sensibly hardened, and that the hardness of the best English tin is to that of the softest lead as four to one.

5. *On the Application of Machinery to the purpose of calculating and printing Mathematical Tables.*—A letter from Mr. Babbage to Sir H. Davy, has appeared under the above title. As we have not seen the machines adverted to, we must rest content with giving the following extract describing their powers and properties, for, of their construction, nothing has as yet transpired.

The first engine of which drawings were made was one which is capable of computing any table by the aid of differences, whether they are positive or negative, or of both kinds. With respect to the number of the order of differences, the nature of the machinery did not in my own opinion, nor in that of a skilful mechanic whom I consulted, appear to be restricted to any very limited number; and I should venture to construct one with ten or a dozen orders with perfect confidence. One remarkable property of this machine is, that the greater the number of differences the more the engine will outstrip the most rapid calculator.

By the application of certain parts of no great degree of complexity, this may be converted into a machine for extracting the roots of equations, and consequently the roots of numbers: and the extent of the approximation depends on the magnitude of the machine.

Of a machine for multiplying any number of figures (m) by any other number (n) I have several sketches; but it is not yet brought to that degree of perfection which I should wish to give it before it is to be executed.

I have also certain principles by which, if it should be desirable, a table of prime numbers might be made, extending from 0 to ten millions.

Another machine, whose plans are much more advanced than several of those just named, is one for constructing tables which have no order of differences constant.

A vast variety of equations of finite differences may by its means be solved, and a variety of tables, which could be produced in successive parts by the first machine I have mentioned, could be calculated by the latter one with a still less exertion of human thought. Another and very remarkable point in the structure of this machine is, that it will calculate tables governed by laws which have not been hitherto shown to be explicitly determinable, or that it will solve equations for which analytical methods of solution have not yet been contrived.

Supposing these engines executed, there would yet be wanting other means to ensure the accuracy of the printed tables to be produced by them.

The errors of the persons employed to copy the figures presented by the engines would first interfere with their correctness. To remedy this evil, I have contrived means by which the machines themselves shall take from several boxes containing type, the numbers which they calculate, and place them side by side; thus becoming at the same time a substitute for the compositor and the computer: by which means all error in copying as well as in printing is removed.

There are, however, two sources of error which have not yet been guarded against. The ten boxes with which the engine is provided contain each about three thousand types; any box having of course only those of one number in it. It may happen that the person employed in filling these boxes shall accidentally place a wrong type in some of them; as for instance, the number two in the boxes which ought only to contain sevens. When these boxes are delivered to the superintendent of the engine, I have provided a simple and effectual means by which he shall in less than half an hour ascertain, whether amongst these 30,000 types, there be any individual misplaced or even inverted. The other cause of error to which I have alluded, arises from the type falling out when the page has been set up; this I have rendered impossible by means of a similar kind.

6. *Strength of Cast Iron.*—The increasing use of cast iron as a substitute for wood in building, has lately drawn considerable attention to the various circumstances affecting its strength and durability. Upon these subjects some interesting and important facts will be found in Mr. Tredgold's practical essay upon the above subject. We may daily observe among the new buildings of the metropolis, entire houses which are stilted, as it were, upon iron columns, with a view of gaining space upon the ground-floor; and in many large buildings, the beams and roofs are entirely of iron, to the complete exclusion of all timber; it gives safety against fire, is not liable to sudden decay, nor soon destroyed by wear and tear; and it can be easily moulded into the form of greatest strength, or that best adapted for the intended purpose. It must, however, be remembered, that iron varies extremely in quality; that the method of casting materially affects its strength; and that this is also greatly dependent upon many minute circumstances, which in ordinary cases are not attended to: such, for instance, as the exclusion of air-bubbles; the temperature of the moulds; and above all, the time allowed for cooling, which, when performed very slowly,

affords a much tougher material than when effected too rapidly. This *annealing* of cast iron, we believe, is frequently neglected, and we can speak from experience of its high importance. The best test of the quality of a piece of cast iron is to strike the edge with a hammer; if it make a slight impression, denoting some degree of malleability, the iron is of a good quality; but if fragments fly off, without any sensible indentation, the iron will be hard, brittle, and not to be relied on. It must, however, be remembered, that in a large beam of iron, different parts will often have different qualities, depending generally upon their situation in the mould. We recommend Mr. Tredgold's book, as calling the attention of practical men to these and several other important subjects, which they are too apt to leave to the honesty or care of the iron-founder, but upon which every architect, engineer, and builder ought to be able to judge for himself.

7. Steam-Engine.—*An Historical and Descriptive Account of the Steam-Engine, comprising a general View of the various modes of employing elastic Vapour as a prime mover in Mechanics; with an Appendix of Patents and parliamentary Papers connected with the Subject: by* Charles Frederic Partington, *of the London Institution*, has just been published. This work, which is illustrated by eight well-executed engravings, and several wood-cuts, contains a perspicuous and popular account of the principal kinds of steam engines now in use, and of the principles upon which they act; and although Mr. Partington has presented us with nothing particularly new or luminous in relation to his subject, he has compiled a book well calculated to instruct the unlearned in these matters, and not useless as a work of reference to the proficient, from the selection of papers and facts which it contains. As such, we are happy to announce and recommend it to our readers.

8. *Steam-Engine Chimneys.*

To the Editor *of the Journal of Science, &c.*

Sir,

In a former number of your Journal, (No. 24, p. 352,) a suggestion is thrown out, that chimneys, in other respects equal, emit smoke in quantities greater or less in proportion to their height.

The object of this communication is to furnish you with a more direct illustration of the truth of that remark, than either of the examples cited in the Journal affords.

In passing through the town of Durham in the winter of 1815, my attention was attracted by a chimney of unusual height, situated at some distance from the town, and on the opposite

bank of the river. Upon inquiry, I learned that this chimney belonged to a steam-engine, employed in a coal mine, and that it had been erected some years before, under the following circumstances:—

The engine had formerly been provided with a chimney of the ordinary kind, from which such volumes of black smoke were discharged, as to render it, when the wind blew in a particular direction, an intolerable nuisance to the town.

When, therefore, the lease expired of the ground upon which the engine was erected, the Dean and Chapter (to whom the ground belonged,) refused to renew it except upon the condition, that a chimney should be erected so high as to carry the smoke completely clear of the town. The condition was acceded to; and a chimney was in consequence built, the summit of which was elevated upwards of one hundred feet above the fire-place. The experiment was completely successful, but not exactly in the manner which had been contemplated; for the town was relieved, not so much by the smoke being carried to a greater elevation than formerly, as by the change which was produced in the quantity and quality of that actually emitted.

Nor had the proprietors any reason to regret the expense to which they had been put in erecting the new chimney; for the quantity of coal consumed by the engine was (as my informant stated) much less than formerly, and the consumption was so perfect, as to render all cleansing of the flue unnecessary.

As the preceding account was received on the spot, and from a person employed in the works, it may, I believe, be considered as in general accurate; but as I cannot vouch for that accuracy from personal experience, I beg leave to suggest the propriety of inviting some inhabitant of Durham to corroborate or to correct the statements it contains. M.

The smoke-burning schemes have all ended in smoke, as we ventured to anticipate would be the case in the article to which our correspondent M. alludes. There can be no doubt that no large engine in the metropolis, or near houses to which it can prove a nuisance, should be suffered to be erected without a chimney at least one hundred feet in height from the ground.

9. *Bridge of the SSa. Trinità, over the Arno, at Florence.*— A description of this celebrated bridge, erected in the middle of the 16th century by Bartolomeo Ammannatti Battiferri, illustrated by plans, sections, elevations, and details of its various parts, has just been published by Mr. L. Vulliamy, who has lately returned to England from a very extensive professional tour through Italy, Sicily, Greece, and part of Asia Minor, in the course of which he has made many hundred drawings of,

various buildings, and of which he intends to publish specimens. He has selected the above beautiful structure as the first publication, because, in addition to its intrinsic value as a work of art, it appears particularly interesting at this time, in consequence of the proposed rebuilding of London Bridge.

II. Chemical Science.

1. *Tincture of Brazil Wood, as a re-agent. By* Mr. P. A. de Bonsdorff.—It is known that the colouring matter of the Brazil wood, treated with an alkaline solution, affords a very fine violet colour. But it possesses another property of some interest to chemistry, that of distinguishing one acid from another, in certain cases. *Sulphuric acid*, concentrated, or diluted with 3 parts of water, instantly gives to paper stained with Brazil wood, a bright rose-colour, which, gradually attracting humidity from the air, passes to orange. Diluted with a little more water, the acid produces a colour bordering on yellow; and with 20 or 30 parts of water it gives, at the end of a minute, a yellow or yellowish colour, which grows dull and dirty. *Nitric and muriatic acids* have the same habitudes with this colour as the sulphuric. *Gaseous sulphurous acid* completely blanches moistened Brazil-wood paper. Concentrated *hydriodic acid* yields a rose-colour, which becomes by degrees yellow on the edges, and, after some days, altogether yellow. Diluted with water, it gives, after half a minute, a tolerably fine yellow, which, however, soon begins to fade After some hours it is fainter, and more red than yellow. *Iodic* acid gives immediately a pale and dull yellow, which remains unchanged. *Fluoric* acid, whether pure, or combined with silica, causes a clear red colour. Diluted, it re-acts in a very decided manner; it instantly produces a fine lemon-yellow colour, which, in the space of a minute, disappears, and soon leaves a tint of greenish-gray, which, observed by transmission, is of an olive-green. In cases where the fluoric acid is evolved in a gaseous form, it is sufficient to submit to its action for a few seconds moistened Brazil-wood paper. The paper passes through the above transitions of colour, a phenomenon which does not occur with any of the other volatile acids. *Fluoboric* acid has the same habitudes as the fluoric. *Boracic* acid does not act at first, but by-and-by the colour of the paper becomes pale, and ends in a white, bordering very little on red. If boracic acid contain traces of sulphuric acid, (which always happens when it is not purified by repeated crystallizations,) its re-action gives rise immediately to a very marked yellowish colour, which soon disappears. The native boracic acid of the island of Volcano, presents very evi-

dently the re-action of pure boracic acid. Concentrated *phosphoric* acid gives a rose-colour, which, on the absorption of humidity from the air, changes slowly to orange. Diluted with from 10 to 30 parts of water, it affords, in half a minute, a very fine yellow colour, which is preserved always without alteration. *Phosphatic* acid resembles phosphoric. *Hypophosphorous* acid gives also a red colour, which passes through pale yellow to white. Diluted, it gives a fine but fugitive yellow. Concentrated *arsenic* acid produces a rose colour, which continues for a long time. Diluted with from 10 to 30 parts of water, it affords, at the end of a minute, a very fine yellow colour, but it loses its brightness in a few minutes, becoming permanently pale-yellow. *Arsenious* acid gives no distinct re-action. Concentrated *acetic* acid gives instantly a *sombre* yellowish colour, which immediately disappears, and is succeeded by a pale violet colour, which, viewed by transmitted light, is a very deep violet-red. Diluted with more or less water, it affords at first a colour somewhat yellowish, and then, both by reflected and transmitted light, a violet-red colour. *Sulphurous* acid, mixed with the acetic, destroys its action, or at least weakens it; and *sulphuric* acid occasions it to give a yellowish colour, instead of the violet-red. An acetic acid, which contains no more than 0.005 of sulphuric acid, affords a very perceptible yellowish colour. *Citric* acid, strong or dilute, gives a beautiful and durable yellow. Tartaric acid occasions also a fine yellow, which soon weakens and becomes dirty, according as the acid is diluted. *Malic* acid resembles tartaric in this respect. Concentrated *oxalic* acid produces an orange-colour, becoming slowly yellow. Diluted, it gives a good durable yellow. *Succinic* acid gives a somewhat yellowish colour, which soon fades. *Benzoic* acid has almost no action on Brazil-wood paper. Woollen-cloth, plunged into a boiling bath of Brazil-wood, then drained, and then dipped for some minutes in a dilute phosphoric or citric acid, or, what is cheaper and equally good, a dilute bi-phosphate of lime, takes a very lively yellow dye which resists washing with soap. Silk may be dyed by the same process, but cotton and linen did not give satisfactory results.—*Annales de Chim. et de Phys*. xix. 283.

2. *The Manufacture of Wine improved by Chalk.*—Count Alexander Czacki, after an experience of four years, recommends the addition of a little chalk to the *must* of grapes, when it is somewhat sour; for the acidity being due to citric and tartaric acids, there is thus formed a precipitate of citrate and tartrate of lime, while the *must* becomes sweeter, and yields a much finer wine. Too much chalk may render the wine insipid, since it is proper to leave a little excess of acid in the *must*. He

concentrates his *must* by boiling, and adds the proper quantity of chalk to the liquor, while it is still hot. Even acid wine may be benefited by the addition of chalk. Oyster-shells, we believe, have been frequently used with this view; and calcined oyster-shells are a cleaner carbonate of lime than common chalk.—*Jour. de Phys.*, May, 1822.

3. *Analysis of Verdigris.*—Before verdigris is pressed into cakes it is in the form of light blue acicular crystals of a silky lustre, which, by the action of water, are resolved into a soluble acetate, and an insoluble subacetate of copper, the latter being decomposed by the action of cold water, which gradually changes it into a brown powder; whether it is thus totally resolved into oxide of copper, or whether it remains a subsalt, Mr. R. Phillips, the author of these researches, has not ascertained.

To find the quantity of acetic acid, 100 parts of the crystals were boiled in water with lime, and the solution, when filtered, was submitted to a current of carbonic acid to precipitate excess of lime; it was then heated to drive off superfluous carbonic acid, and the neutral acetate of lime thus obtained was decomposed by carbonate of soda; the carbonate of lime thus precipitated weighed, when washed and dried, 28.3 parts.

To ascertain the proportion of peroxide of copper, 100 parts of the blue crystals were heated with dilute nitric acid, and the nitrate of copper thus formed being decomposed by a red heat, left 43.25 parts of peroxide of copper. The equivalent of acetic acid, in reference to hydrogen as =1, being 50, and that of carbonate of lime also 50, the quantity of the latter obtained in the above experiments indicates that of the acetic acid, which, added to the oxide, gives as the composition of the silky blue crystals,

	Experiment			Theory
Acetic acid . .	28.30=1	proportional	50	=27.17
Peroxide of copper	43.25=1	,,	80	=43.47
Water	28.45=5	,,	54	=29.36
	100.		184.	100.

Mr. Phillips found the green decomposable powder obtained by acting upon the silky crystal by water, to be a subacetate consisting of

1	proportional of acid		= 50
2	,, peroxide of copper . .	80×2	=160
			210

The water retained a binacetate in solution.

It appears therefore that there are the following peracetates of copper, which, independent of water, are composed as follows:

Acetic acid -	2 proportionals	$50 \times 2 = 100$	}	$= 180$ bi-peracetate.
Peroxide of copper	1 ditto	$= 80$		
Acetic acid .	1 ditto	$= 50$	}	$= 130$ peracetate.
Peroxide of copper	1 ditto	$= 80$		
Acetic acid .	1 ditto	$= 50$	}	$= 210$ subperacetate.
Peroxide of copper	2 ditto 80×2	$= 160$		

To shew that verdigris agrees in composition with the blue silky crystals above analyzed, Mr. Phillips has given the following analysis of French and English verdigris:

	French Verdigris.	English Verdigris.
Acetic acid	29.3 . .	29.62
Peroxide of copper . . .	43.5 . .	44.25
Water	25.2 . .	25.51
Impurity	2.0 . .	0.62
	100.0	100.00

(*Phillips's Annals. No.* 21.)

4. *Black Enamel obtained from Platinum.*—Mix a solution of muriate of platinum with one of neutral nitrate of mercury, and expose the precipitate to a heat sufficient to drive off the protochloride of mercury: you will obtain a black powder, which, applied with a flux, produces a fine black enamel. (*Annales de Chim. et Phys.* xx. p. 198.)

The above extract from the *Annales de Chimie et Physique*, for June 1822, is evidently derived from Mr. Cooper's paper, which appeared in this Journal in the year 1817. (*See* Vol. III., p. 119.)

5. *Test for Magnesia.*—In the *Annales de Chimie* for May last, it is stated, that if we spread any clear liquid upon a plate of glass, and then trace the word *Magnesia* upon the glass so covered, with the end of a glass rod, that word will appear in *white characters* if magnesia be present in the solution; if not, no such appearance will result. It is, moreover, stated, that this method of discovering the presence of magnesia originated with Dr. Wollaston, and was communicated to the Editors by M. Clement.

In the same journal for July, M. Clement writes as follows to the Editors:

" Gentlemen,—In your number for May last you have given a very inaccurate report of a neat experiment which Dr. Wollaston was so kind as to show me when in London. The precipitation upon the written characters only ensues when the magnesian solution has been previously decomposed by a mixture of phosphate and carbonate of ammonia. This substance, re-dissolved by the excess of carbonate, is precipitated upon

the traces of the glass rod, in consequence of the expulsion of carbonic acid by the heat disengaged by friction."

6. *On the Uses of Sulphate of Lead in the Arts.*—Those dyers and calico-printers who prepare their aluminous mordaunt by decomposing alum by acetate of lead, obtain at the same time a large quantity of sulphate of lead. M. Berthier, in a paper published in the *Annales de Chimie et Physique*, has detailed the various uses which may be made of this product. In the first place, it may be reduced into metallic lead. When sulphate of lead is heated to redness with a sufficient quantity of charcoal powder, half the sulphuric acid which it contains is converted into sulphurous acid, and the sulphur belonging to the other half forms a *subsulphuret* with the lead. The sulphurous acid carries with it a portion of the subsulphuret in the state of vapour. When the heat is carried beyond redness, the subsulphuret is decomposed, and changed into another sulphuret, which is volatilized, and into lead which remains mixed with the undecomposed subsulphuret. The higher the temperature, the greater the loss of lead by volatilization.

100 grains of sulphate of lead, mixed with 9 grains of charcoal, and heated in a retort, gave out sulphurous acid gas for half an hour; a scoriform mass of subsulphuret of lead remained, and carbonic acid and oxide were also evolved.

10 grains of sulphate of lead, heated for half an hour in a coated crucible, in a calcining furnace, yielded a metallic scoria weighing 7.1 gr. It consisted of 0.4 sulphur and 6.7 lead. Sulphate of lead only contains 0.683 of metal, so that very little was volatilized.

These, and similar experiments, shew that, by uniting sulphate of lead with about one-tenth its weight of charcoal, it is converted into subsulphuret without material loss of weight. This subsulphuret may be treated as galena, and the lead easily extracted. But there is a simple and more economical means of reducing sulphate of lead. Sulphate and sulphuret of lead may be made mutually to decompose each other, and if mixed in proper proportions pure lead is the result. Pure lead may also be obtained from a mixture of sulphate and subsulphuret of lead, as the following experiment proves. 20 grains of sulphate, mixed with 29 grains of subsulphuret, were heated to whiteness in an earthen retort; pure sulphurous acid was evolved, and a button of ductile metallic lead, weighing 38 grs., was obtained, covered with a thin crust of vitrified oxide. As the original mixture only contained 40 grains of lead, it will be observed that the entire loss of metal in the above reduction amounted to five per cent. only. If sulphate of lead be heated with such proportion of charcoal as is insufficient to reduce it entirely to sulphuret, that portion of sulphuret which

is formed will re-act upon the undecomposed sulphate; and if the proportions be so arranged, that the sulphuret and sulphate are to each other as 29 to 20, the product of the operation ought to be pure lead. This is the case when sulphate of lead is heated with 0.06, its weight of charcoal.

Secondly, Sulphate of lead may be converted into oxide, by heating it to whiteness with 0.03, its weight of charcoal. The oxide which I thus obtained was compact, vitreous, transparent, and of a fine resin-yellow colour. We see, then, that by the aid of charcoal only, we may convert sulphate of lead into sub-sulphuret, into pure lead, and into pure oxide. We may also decompose sulphate of lead by metallic lead; for this purpose the proportion of metal should be 0.68 that of the sulphate. With these proportions I obtained a very pure oxide. One may also convert sulphate into oxide of lead, by heating it with sub-sulphuret in the proportion of 7.3 parts of the latter to 10 of the sulphate.

Thirdly, Sulphurous acid may be obtained from sulphate of lead: but as this acid could only be used for the production of sulphuric acid, and, therefore, only as a substitute for sulphur, it is useless to enter into the details of this decomposition.

Fourthly, In the lead furnaces, sulphate of lead and galena may be conveniently reduced together. 79 parts of galena, and 100 of the sulphate, treated as usual in the reverberatory furnace, afford about 137 parts of metallic lead.

Fifthly, Sulphate of lead may be decomposed by silica. 11 grains of sulphate of lead were mixed with 16 of finely-powdered rock crystal; this mixture was ignited for an hour in a small Hessian crucible; the loss of weight sustained in this operation amounted to 3.3 grains, which is little more than the weight of the sulphuric acid contained in the sulphate. A white, spongy, and translucent enamel was thus obtained. 4 parts of quartz, and 12 of sulphate, and 4 of quartz and 6 of sulphate, afforded compact and transparent yellow glasses, and the sulphate was in all cases decomposed.

Sixthly, Sulphate of lead may be used for glazing pottery, and it may be substituted for minium in the manufacture of glass and pastes.

Lastly, Sulphate of lead may be decomposed by carbonate of ammonia or carbonate of potassa, for the production of *white lead*. The former operation can only be economically practised by manufacturers of sal ammoniac, and it is doubtful whether the latter would afford a ceruse equally fit for the painter's use with that obtained by other and cheaper methods. (*Annales de Chimie et Physique*, T. xx. p. 275.

7. *Green Fire.*—In a former number of this Journal we

presented our pyrotechnical readers with a recipe for the *red fire* which has lately gained so much celebrity in the theatrical representations of conflagrations, and which forms so beautiful a change in fireworks. We now give them the component parts of a more modern invention, which has long been a desideratum in this branch of art, namely, a *green fire*, and which, when burned in a reflector, sheds a beautiful green light upon all surrounding objects; it may also be employed in the changes of fireworks alternating with red and blue fire. Take of

Flowers of sulphur . .	13 parts.
Nitrate of baryta . . .	77
Oxymuriate of potassa . .	5
Metallic arsenic . . .	2
Charcoal	3

The nitrate of baryta should be well dried and powdered; it should then be mixed with the other ingredients, all finely pulverized, and the whole triturated until perfectly blended together. A little calamine may be occasionally added, in order to make the compound slower of combustion; and it is above all things requisite, that both in this and the red fire the trituration of the materials should be continued until they are completely mixed.—T. G.

8. *Composition of Tutenag, or Chinese White Copper.*—This celebrated alloy has been analyzed by Dr. Fyfe, who gives the following as its composition :—*(Edinburgh Philos. Journal.)*

Copper	40.4
Zinc	25.4
Nickel	31.6
Iron	2.6
	100.0

9 *Effect of Voltaic Electricity upon Alcohol.*—M. Lindersdorff produced an ethereal fluid by the action of the voltaic pile upon alcohol; and by continued electrization, a mixture of equal parts of alcohol and liquid ammonia lost its inflammability, and acquired a bitter flavour, yellow colour, and nauseous odour. On evaporation it left a greasy residue.

These are very interesting results.

10. *Artificial production of Formic Acid*, by M. Doebereiner.—When a mixture of tartaric acid, or of cream of tartar, black oxide of manganese and water is heated, a tumultuous action ensues, carbonic acid is evolved, and a liquid acid distils over, which has been, upon superficial examination, mistaken for

acetic acid, but which more careful investigation proves to be formic acid.

This acid, mixed with concentrated sulphuric acid, is converted at common temperatures into water and carbonic oxide; nitrate of silver, or of mercury, convert it, when gently heated, into carbonic acid, the oxides being at the same time reduced to the metallic state. With baryta, oxide of lead, and oxide of copper, it produces compounds, having all the properties of the genuine *formiates* of those metals.

The residue of the mutual action of the tartaric acid and oxide of manganese, is a mixture of formiate and tartrate of manganese; they may be separated by water, which only dissolves the formiate.

If a portion of sulphuric acid be employed in the above process, the tartaric acid is entirely resolved into carbonic acid, water, and formic acid, the product of the latter being much increased. The best proportions are,

2 parts of crystallized tartaric acid,
5 peroxide of manganese,
5 concentrated sulphuric acid, diluted with about twice its weight of water.

M. Doebereiner remarks that in several processes in which the formation of acetic acid has been suspected, it is not impossible that formic acid has been produced. The relations which he has pointed out between the formic acid and sulphuric acid and the soluble salts of silver and mercury, whether it be dissolved in water or combined with a base, are sufficient to distinguish it from the acetic acid. *Annalen der Physik*, LXXI. 107.

[The Editor of the *Annales de Chimie*, whence we have extracted the above, informs us, that he has repeated the experiments and verified the conclusions of M. Doebereiner. The possible identity of lampic and formic acids has occurred to us, whilst transcribing the preceding details.]

11. *Action of Water on Metallic Arsenic.*—If water be boiled on metallic arsenic, which has been previously freed from any adhering oxide, still the water will be found to contain, upon examination, abundance of oxide of arsenic. If water be distilled from off the metal, oxide of arsenic will pass over in solution. These experiments indicate a decomposition of the water by the metal; but the hydrogen which might be expected to result from such decomposition, has not yet been obtained. It probably unites with the arsenic to form an *hydruret.*—T. G.

12. *Considerations on the existence and state of Sulphur in*

Vegetables.—M. Planche suspended a piece of rag, impregnated with acetate of lead, and also a plate of clean copper, within the capital of an alembic in which he was drawing off distilled waters from plants, and found that the above re-agents were powerfully acted on, as if they had been exposed to a stream of sulphuretted hydrogen. He found, moreover, that water and sulphur boiled together, as also roll sulphur heated, without the addition of water, evolved sulphuretted hydrogen; and from the two latter experiments he infers, that in plants the sulphur is in its simple state.

According to MM. Thibierge and Robiquet, the oil of mustard contains a pretty large quantity of sulphur; and from some comparative trials, it seems there to be in the state of sulphuretted hydrogen. In fact, distilled water, saturated with the essential oil of mustard, blackens the solution of nitrate of silver. Oil of caraways absorbs a very large quantity of sulphuretted hydrogen gas, when it is passed through it; and assumes, in consequence, a very fetid odour. He supposes that the sulphur which exists as such in the mustard-seed, is converted into sulphuretted hydrogen during distillation with water, and in this state unites to the oil. A portion of the sulphur is deposited at the end of some days. The following plants yielded much sulphur: the flowers of the elder, linden, and orange-tree; the whole plant of pellitory and mercury; the flowering tops of hyssop, melilot, tarragon, and rue; the seeds of dill, caraway, cummin, and fennel; and clove-buds. — (*Journal de Pharmacie, Aug.* 1822.)

13. *Action of Salts on Turmeric Paper.*—Among the salts not alkaline, which have the power of affecting turmeric paper like alkalies, (see page 315, last No.), those of uranium are perhaps most powerful. The muriate, sulphate, and acetate affect turmeric paper strongly, even when considerably diluted; but the nitrate is the most powerful. A strong solution scarcely seems to have its power diminished by dilution with ten or twelve times its weight of water; and even when the solution contains only $\frac{1}{500}$ of dry nitrate of uranium, it sensibly browns turmeric paper.

The muriate of zirconia also possesses this property to a considerable degree.—M. F.

14. *Detection of Poisons.*—A paragraph has appeared in the papers, recommending blue sugar-loaf paper as a test of distinction between oxalic acid and Epsom salt; it is reddened by the former, but not affected by the latter. This is perfectly true; but a simpler test consists in wetting the tip of the finger, applying it first to the supposed salt, and then to the tongue—

if oxalic acid, it tastes *very* sour; if Epsom salt, very bitter and saline.

Many restrictions have been suggested upon the sale of arsenic; the only effectual bar to the mischief that results from it, is *prohibition.* It is of no use in medicine, and should therefore be rejected from the pharmacopœia. Apothecaries and druggists need not then keep it. It is sometimes employed as an instrument of research, in the chemical laboratory, which might be sufficiently supplied through other channels.

15. *Analysis of the Resin Elemi.*—This substance, the produce of the *Amyris Elemifera,* (*Linn.*), has been carefully examined by M. Bonastre; it is imported in considerable masses from America, packed in chests lined with tin plate; it has an acrid taste, and an odour partaking both of camphor and lemon. It affords of

Clear resin, soluble in cold alcohol	60.00
White opaque matter, soluble in boiling alcohol,	24.00
Volatile oil (distilled over)	12.50
Bitter extractive matter	2.00
Impurities	1.50
	100.

Elemi is sometimes adulterated with the resin of the pinus australis, which is easily recognised by its entire solubility in cold alcohol.—(*Journ. de Pharmacie, Aug.* 1822.)

III. Natural History.

1. *Beds of Lignite in Russia.*—Professor Kounizin has observed, in the government of Novogorod and Twer, extensive strata of fossilized wood, parallel to the horizon. All the trees have their summits directed towards the same quarter, and they are merely inclined. They are placed with their roots, in the spot where they vegetated. The earth which covers them is partly sand, partly clay, and it is sometimes six and a half feet thick. In moist clayey soils the trees are best preserved, and are sometimes petrified. It is a remarkable fact, that oaks are there found, in a country, where none grow at present; a country cleared of trees from time immemorial. The tops of the trees are turned towards the south-east and south-west; consequently, the force, which overturned them must have acted in a southerly direction. Beds of this fossil-wood are to be met with in the whole of Northern Russia.

2. *Remarkable Glacier.*—M. Otto de Kotzebue, lieutenant in the Russian navy, has discovered, in the western part of the gulf, to the north of Behring's Strait, a mountain covered with verdure (with moss and grass), composed interiorly of solid ice. On arriving at a place where the shore rises almost perpendicularly from the sea to the height of 100 feet, and continues afterwards to extend with a gradual inclination, they observed masses of the purest ice, 100 feet high, preserved under the above vegetable carpet. The portion exposed to the sun was melting, and sending much water into the sea. An undoubted proof of the ice they were contemplating being primitive, was afforded by the great number of bones and teeth of mammoths, which make their appearance when it is melted. They could not account for a very strong smell, similar to that of burning horn, which was exhaled in that country. The soil of these mountains, which to a certain height are covered with an abundant herbage, is only half a foot thick. It is composed of a mixture of clay-earth, sand, and mould; the ice melts gradually beneath it; the carpet falls downwards and continues to thrive. The latitude is 66° 15′ 36″ N.—*Gilbert's Annalen*, 1821, *Stuck*.10.

3. *Eruption of Mount Vesuvius.*—On the 17th February last, at one o'clock, P. M., a variety of detonations announced the approaching eruption, which took place next day, consisting of immense volumes of smoke, of cinders, and *lava*. The 19th and 20th, the eruption became more violent. On the 21st the volcanic matters opened up a new passage on the northern side; and an immense quantity of lava flowed slowly on the side of the extremity of San Salvadore. The same phenomena continued the 22d and 23d, but on the 24th the volcano appeared in greatest activity. Vesuvius exhibited in the evening the superb spectacle of a river of fire, rolling its stream through clouds and smoke, and forming a blazing cataract. The eruption ceased on that day.—*Journ. de Phys.*, *April*, 1822.

4. *Fossil Remains.*—For the present we must content ourselves with merely informing our readers, that Mr. Parkinson has published a very useful *Introduction* to the study of organic remains. We hope in our next to enter into further details.

5. *New Locality of Arragonite.*—A cavity, lined with arragonite, was lately observed by Mr. Mawe in the gypsum of Derbyshire; it resembled that variety usually called *flos-ferri*. New editions of Mr. Mawe's *Elements of Conchology*, and of his *Treatise on Diamonds and Precious Stones*, are lately published.

6. *Intestinal Concretions.*—A woman, aged 35, a patient of Dr. Champion, of Bar-le-Duc, was subject to frequent vomitings

of blood, in which concretions were occasionally found of the size of small hazel-nuts, and with a tuberculated surface; their texture is usually compact, but sometimes rather cellular, and in two instances hollow. They were submitted to a chemical examination by M. Braconnot. Boiled in water they lost a small quantity of saline and animal matter; they were then submitted to the action of boiling solution of potash, by which they were scarcely affected; they were subsequently dried, pulverized, and digested in sulphuric acid, which produced a thick mucilage, soluble in water, and was converted after some hours' boiling into sugar. Muriatic acid exerted no action upon these concretions, but they were decomposed by nitric acid. They burned with flame, but without the disagreeable odour of animal matter. Upon the whole, they may be regarded as composed of woody fibre, and resemble some bezoars sent to France by the king of Persia, and examined by M. Berthollet*; but how were these woody concretions formed? In answer to this question M. Braconnot's observations are far from furnishing any intelligible reply.—*Ann. de Chim. et Phys.*, XX. 194.

7. *Anatomy of the Brain.*—A new periodical work has been just published, entitled, "Anatomical and Physiological Commentaries, by Herbert Mayo, Surgeon and Lecturer on Anatomy." Our readers will here find a translation of Keil's *Essays on the Structure of the Brain*, which, although scarcely known in this country, appear to possess the highest interest and importance; we are, therefore, glad to see them at length introduced to the English reader.

8. *Employment of Iodine for the Relief of Cancer.*—We have heard that iodine, in the form of alcoholic solution, duly diluted with simple sirop, has been used with success in one of the Paris hospitals in allaying the pain and increase of a cancerous tumour in the breast; but we have been unable to obtain from our correspondent any satisfactory particulars of the case; we, therefore, merely throw out the rumour for the consideration of our medico-chirurgical readers.

9. *Effects of drinking Boiling Water.*—It is the custom of some poor and thoughtless persons to suffer children to drink from the spout of a tea-kettle while filling it at the pump; they have afterwards attempted to drink when it has just been taken from the fire, supposing it still to contain cold water. No less than four cases of this kind are related in the *Medico-Chirurgical Transactions*, by Dr. Hall. The symptoms produced are those of *croup*, that is, of inflammation of the glottis and larynx, and not, as might have been expected, of the

* *Mem. d'Arcueil*, II, 448.

œsophagus and stomach. It appears, indeed, probable, that the boiling water does not actually reach the stomach, but that it is arrested by spasm of the pharynx. Dr. Hall recommends an incision into the windpipe, but the only case of this operation which he relates, proved, as might have been expected, fatal. Where the injury is extensive there seems to be no remedy.

10. *Cure of Ring-worm.*—Mr. T. J. Graham, of Cheltenham, recommends the lime-water which has been used for purifying gas, as a very efficacious remedy in the above troublesome disease. The head is to be well cleansed morning and evening with soap and water, and afterwards washed with the lime-water from the gas-works. (*Monthly Mag. Sept.*) The above *lime-water* is a very heterogeneous compound, so that it is impossible to say which of its ingredients is effectual. It contains lime, ammonia, sulphuretted hydrogen, volatile oil, and, probably, several other compounds of a more complex nature.

11. *Mineralogy.*—A work on the science of mineralogy is about to make its appearance in Germany. It is from the pen of Mr. Frederick Mohs, Professor of Mineralogy at Fryberg, and will contain the terminology, the rules of the construction of Mr. Mohs' system, and the nomenclature, the characteristic and the descriptive part of natural history. The whole to be comprised in two volumes octavo, with plates.—An English translation will appear at the same time, made under the inspection of the author, by Mr. Haidinger, who lately visited this country, in company with Count Brenner. From the known celebrity of the Fryberg school, as well as the acknowledged ability of the author, we have reason to expect that this will be a useful work.

12. *Caterpillars.*—The following is a method of guarding cabbages from their depredations. Sow a belt of hemp seed round the borders of the ground where the cabbages are planted, and not one of these vermin will approach the space enclosed by the hemp. (*New Monthly Mag., Aug.*) *Quære.* Do caterpillars dislike hemp, or are they so fond of it that they eat it in preference to the cabbages ?

13. *Diseases of the Spine.*—Mr. Shaw has in the press a work on this subject. The first part will treat of the distortions to which young persons are subject in consequence of habitual bad postures and the neglect of proper exercise. The second part will embrace scrofulous diseases of the spine. The whole will be illustrated by engravings.

Art. XV.—METEOROLOGICAL DIARY for the Months of June, July, and August, 1822, kept at Earl Spencer's Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern spect, about five feet from the ground, and a foot from the wall.

For June, 1822.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Saturday	1	48	69	30.05	30.04	W	WNW
Sunday	2	48	74.5	30.09	30.07	E	E
Monday	3	51	75.5	30.09	30.08	E	E
Tuesday	4	48	78	30.10	30.05	E	E
Wednesday	5	52	83.5	30.05	30.04	E	NNE
Thursday	6	57	80	30.04	30.06	NE	E
Friday	7	52	68	30.08	30.03	E	E
Saturday	8	50	70	30.00	29.90	ENE	EbS
Sunday	9	49	80.5	29.84	29.81	E	EbS
Monday	10	55.5	81	29.87	29.87	NE	NE
Tuesday	11	56	73	30.00	30.01	NE	NE
Wednesday	12	52	80	30.07	30.10	NE	NE
Thursday	13	39	69.5	30.12	30.00	NE	NE
Friday	14	41	79	29.90	29.70	SW	SW
Saturday	15	58	72	29.57	29.57	NW	ESE
Sunday	16	52	67	29.79	29.88	E	EbS
Monday	17	53	69	30.03	30.09	E	NE
Tuesday	18	42	75	30.10	30.01	ESE	NE
Wednesday	19	49	73	29.93	29.80	W	NW
Thursday	20	56	65	29.87	29.97	NE	NE
Friday	21	38.5	66	30.09	30.03	NE	EbS
Saturday	22	42	73	30.03	29.97	E	SW
Sunday	23	50	76	29.90	29.83	bES	SW
Monday	24	55	78	29.88	29.90	W	WbN
Tuesday	25	55	76	29.97	29.97	W	W
Wednesday	26	52	79.5	29.93	29.83	W	W
Thursday	27	56	75	29.97	30.04	WNW	NW
Friday	28	52	71.5	30.00	29.83	SW	SW
Saturday	29	55	66	29.87	29.97	W	WbN
Sunday	30	44	70	29.90	29.79	SW	W

For July, 1822.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Monday	1	51	72	29.80	29.67	W	WNW
Tuesday	2	49	70	29.00	29.67	SW	SW
Wednesday	3	43	70.5	29.80	29.67	W	WbS
Thursday	4	55	76.5	29.85	29.8[illegible]	SW	SW
Friday	5	57	71	29.70	29.03	SW	NW
Saturday	6	45	62	29.78	29.87	NE	E
Sunday	7	47	70.5	29.97	29.98	WSW	W
Monday	8	56	66	30.02	30.05	W	WNW
Tuesday	9	50	67	30.00	29.85	WSW	W
Wednesday	10	60	71	29.70	29.70	NW	W
Thursday	11	53	74.5	29.71	29.50	NW	SE
Friday	12	52	69	29.29	29.45	W	NW
Saturday	13	44	70	29.74	29.81	NW	N
Sunday	14	43	72.5	29.90	29.84	E	EbN
Monday	15	48	70	29.90	29.89	E	E
Tuesday	16	54	65	29.75	29.70	NE	NbW
Wednesday	17	5[illegible]	71.5	29.59	29.[illegible]	N	S
Thursday	18	47	73	29.01	29.[illegible]	SE	SE
Friday	19	61	74	29.42	29.34	E	SbE
Saturday	20	54	70	29.30	29.40	SE	SE
Sunday	21	55	70	29.43	29.45	S	SW
Monday	22	58	72	29.48	29.62	W	W
Tuesday	23	57	70	29.67	29.56	S	SSE
Wednesday	24	60	74	29.47	29.47	SW	WbS
Thursday	25	57	73	29.47	29.50	SW	SW
Friday	26	51	73.5	29.40	29.62	WbS	SSW
Saturday	27	46	75	29.67	29.65	W	SE
Sunday	28	56	73.5	29.43	29.37	WbS	WSW
Monday	29	54	74	29.39	29.40	WbS	NE
Tuesday	30	52	64	29.42	29.48	NNW	NW
Wednesday	31	45	68	29.53	29.53	SW	WSW

For August, 1822.

		Thermometer		Barometer		Wind	
		Low	High	Morn.	Eve.	Morn.	Eve.
Thursday	1	44	69	29.63	29.67	WbS	WbS
Friday	2	45	68	29.60	29.77	W	NW
Saturday	3	44	67	29.90	29.89	W	NW
Sunday	4	42	68	29.80	29.72	NW	NW
Monday	5	49	67	29.74	29.80	NW	NW
Tuesday	6	49	67	29.86	29.90	W	NW
Wednesday	7	48.5	72	29.92	29.92	W	W
Thursday	8	49	77	29.90	29.79	W	WSW
Friday	9	51	70	29.66	29.62	WbS	W
Saturday	10	53	69	29.64	29.67	W	W
Sunday	11	57	73.5	29.70	29.70	W	SW
Monday	12	52	75	29.70	29.70	SW	WbS
Tuesday	13	59	79.5	29.60	29.71	W	WbS
Wednesday	14	58	72	29.78	29.64	SW	SE
Thursday	15	57	71	29.48	29.74	W	W
Friday	16	47.5	70	29.88	29.91	W	W
Saturday	17	51	75	30.06	30.06	W	W
Sunday	18	49	73	30.10	30.04	WbN	WbN
Monday	19	48	74	30.04	30.00	NW	E
Tuesday	20	53	74	30.05	30.00	E	E
Wednesday	21	56	79	29.96	29.84	NE	SE
Thursday	22	54	79.5	29.80	29.78	W	WbS
Friday	23	53	70	29.84	29.86	SW	WbS
Saturday	24	50	68	29.79	29.69	NW	SW
Sunday	25	48	70	29.59	29.59	W	SW
Monday	26	50	68	29.54	29.54	SbW	SW
Tuesday	27	48	68	29.56	29.56	W	W
Wednesday	28	49	68.5	29.60	29.49	SbW	SE
Thursday	29	51	66	29.33	29.39	W	W
Friday	30	49	70	29.57	29.62	W	W
Saturday	31	45	71	29.74	29.82	W	NE

The First Course *of these Lectures will commence on* Tuesday, *the* 8th *of* October, *at* Nine *in the Morning precisely. The* Second Course *will begin on the* Second Tuesday *in* February, *at the same hour.*

The Royal Institution,

ALBEMARLE-STREET.

PLAN

OF

THE LECTURES AND DEMONSTRATIONS ON

CHEMISTRY,

DELIVERED IN THE LABORATORY OF THE ROYAL INSTITUTION,

BY WILLIAM THOMAS BRANDE, F.R.S.,

Secretary of the Royal Society of London, and F.R.S. Edinburgh; Professor of Chemistry in the Royal Institution, and of Chemistry and Materia Medica to the Apothecaries' Company.

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In the FIRST DIVISION of each Course, the principles and objects of Chemical Science, and the general Laws of Chemical Changes, are explained, and the phenomena of Attraction, and of Light, Heat, and Electricity developed, and illustrated by numerous Experiments.

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The applications of Chemistry to the Arts and Manufactures, and to Economical Purposes, are discussed at some length in various parts of the Courses; and the most important of them are experimentally exhibited. The various operations of Analysis are also shewn and explained.

Further particulars may be had by applying to Mr. Brande, No. 2, Clarges-Street, Piccadilly; or to Mr. Fincher, at the Royal Institution, 21, Albemarle-Street.

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QUARTERLY JOURNAL,

January, 1823.

Art. I. *On the Climate of South Africa.* *By* H. T. Colebrooke, Esq., F.R.S.

THE mean temperature of Cape-Town, inferred from a meteorological journal kept there for several years, is $67\frac{1}{3}$° Fahr*. The extremes, according to the same journal, are 96°, and 45°. But, as the thermometer, of which the account was kept, remained suspended in a large apartment, without direct exposure to external air, it cannot have indicated precisely the extreme of cold, nor perhaps that of heat. Besides, it is not self-registering. The mean temperature of the coldest month, as shewn by it, was 57°; of the hottest, 79°; mean of three winter months, 58°; of three summer months, 77°; least heat during summer, 63°.

The temperature of an inland station, Stellenbosch, deduced from observations of a single twelvemonth†, is $66\frac{1}{3}$°; extremes, 87° and 50°. The temperature of Zwartland, another inland station, appears to be $66\frac{1}{2}$°; extremes, 85° and 54°. The exposure of the thermometers is at neither place external; they are suspended in spacious airy halls.

At Tulbagh, situated in a valley of the great chain of mountains, which divides the western from the eastern districts of the colony of South Africa, the mean temperature of the year is

* Published for nearly three years, in the Cape-Town Gazette.

† Published in the same newspaper.

$66\frac{2}{3}^\circ$; that of the coldest month, $55\frac{1}{2}^\circ$; of the hottest, $80\frac{1}{2}^\circ$; extremes, 95° and 52°; mean of three winter months, $56\frac{1}{2}^\circ$; of three summer months, 79°; least heat in summer, 61°.

Beyond the great chain of mountains, a material difference in climate is perceptible. But meteorological diaries, kept at the principal stations, do not extend to a sufficiently long period, for confidently deducing from them positive conclusions. It would be unsafe to do so from a journal of a single twelvemonth, unchecked by personal knowledge of the place. It should appear, however, that the eastern division of South Africa is subject to a colder winter than the western. The extreme of cold, quoted at Uitenhage, is 32°; at Bathurst, 44°.

The climate of the western tract, constituting the belt of land between the range of high mountains and the sea, from St. Helena bay and the Berg river, to the southern termination of the peninsula, or Cape of Good Hope, consisting of the Stellenbosch and Cape districts, with part of Tulbagh, and comprising the most populous and best cultivated portion of the colony, exhibits, for the mean temperature of the year, according to the diaries above cited, 66° to 67°; coldest month, 56° to 58°; hottest month, 77° to 80°; extremes, 96° and 45°; mean of three winter months, 56° to 60°; mean of three summer months, 75° to 79°; least heat in summer, 61° to 63°.

The winter lasts from June to August; and the whole of the cold and rainy season, from May to October. The summer continues from December to February; and the whole of the warm and dry season, from November to April. The north-western monsoon extends from the middle of April to the middle of September, five months: the south-eastern monsoon, seven months, from September to April.

At the Cape, as in the south of Europe, and most of the warm climates of a temperate zone, wind commonly blows cool in summer, at the same time that the sun shines powerfully. It is this circumstance, which distinguishes a warm from a hot climate. Parched winds and frequent summer calms, equally make a hot climate. In a cool one, or merely warm, the temperature of the air, in the shade, and in ventilated sun-

shine several feet from the ground, does not much vary; but, in a screened situation, or at the surface of the ground, the heat of a sunny exposure, at noontide of a summer's day, becomes intense. That intensity of heat is, in strictness, superficial, scarcely penetrating an inch beneath the surface, nor reaching more than a foot or two above it. In calm weather, the range of reflected heat is somewhat greater.

A few observations, extracted from my diary *, will prove this assertion, as applicable to the Cape.

At the foot of the great mountains, and within the verge of their influence, the heat of the atmosphere over the valleys and

* Jan. 15, 1822.—On the acclivity of Table Mountain, noon, wind S.E., a cloud on T. M.

Temperature in sunshine, exposed to the wind, 70°.

Surface of white sand, 113°; at depth of three inches in the sand, 95°; hygrometric thermometer, 59°.

Jan. 21.—Among sand-hills, on the isthmus between Table-Bay and False-Bay, 4 p. m., wind S.E., clouds on mountain summits.

Sunshine, exposed to wind, 77°; surface of white sand, 98°; under the sand, at depth of three inches, 93°.

Jan. 22.—At Hottentots' Holland, noon, wind E.S.E., light breeze.

In the shade, exposed to the wind, 81°; screened, 85°; in glare, 87°; in sunshine, 3 to 5 feet from the ground, 92° to 90°; surface of garden-mould, (black loam,) 118°; at depth of three inches in the mould, 92°; hygrometric thermometer, 70°; dryness, 81° — 70° = 11°.

Jan. 25.—Same place, wind E.S.E. moderate, increasing; clouds on mountain summits.

6 A.M., dryness, 68° — 61½° = 6½°.

9½ A.M., in sunshine and wind, 78°; surface of garden-mould, 88°; at depth of three inches, 76°.

Noon, in shade, 78½°; in glare, 83½°; on the ground (thermometer laid upon the surface,) 92°; covered with garden mould, 100°; (thermometer was broken in thrusting it into the ground,) hyg. therm. 65½°.

2½ P.M., shade, 81°; glare, 86°; hyg. therm. 67°.

Jan. 27.—Same place, wind S.W., moderate.

6 A.M., dryness, 71° − 63° = 8°.

Noon, dryness, 84° − 66° = 18°.

2½ P.M., in sunshine, 92°; garden-mould, 135° (thermometer laid upon the surface, 125°), hyg. therm., 66°.

Feb. 17.—Same place, wind S., moderate, mountain summits clear.

5 A.M., dryness, 73° − 61° = 12.

1¼ P.M., in shade, 92°; surface, of black loam, 145°; hyg. therm., 67°.

Feb. 21.—Same place, wind S.E., brisk breeze, clouds above summits of mountain.

5½ A.M., dryness, 62° − 54° = 8°.

2 P.M., in shade, 79; sunshine, 84°; surface of garden-mould, 98°; hyg. therm. 61°.

the plain is mitigated by a cool wind descending from the mountain's side, and the coldness of the blast is tempered by the reflected heat of the earth's surface. Hence a moderate temperature, where the wind has free passage, is the result, even in summer, at the Cape. The prevalence of clear sunshine, with the consequent heat of the ground, is at the same time sufficient for ripening the productions of warm climates; while the winter, which is likewise moderate, is, in a similar degree, suited to the summer produce of cooler regions.

Concerning the hygrometric condition of the atmosphere, I have to adduce none but desultory observations made by myself, during a few months. They were summer months; and the observations have supplied some facts, which I have used, and shall further employ, in course of touching upon topics on which they bear.

I use, by way of hygrometer, a common thermometer, of which the scale is detached from the bulb. Upon wetting the bulb with water, and exposing it wet to the air, the consequent evaporation of moisture from its surface lowers the temperature more or less, according to the dryness of the air.

For a common measure to serve for comparison, the degrees of dryness are reduced to the centesimals of the air's capacity for moisture, at the observed temperature.

The following is a summary of observations with this very simple instrument, during summer months (December to March), at Cape-Town, near Table-Bay; and at Hottentots' Holland, near False-Bay.

Dryness, in the morning before sunrise, is ordinarily from 6° to 7°, the utmost 12°, the least 3°; which, for a mean temperature of 77°, answer to about .17 to .20 centesimals .30, and .09, respectively. The atmospheric dryness usually augments as the day advances; for, while the temperature rises towards noon, the point at which the hygrometric thermometer becomes stationary, remains more nearly uniform. The maximum at noon was 26°, (*viz.*, 92° — 66°). The utmost range of difference of dryness within the day amounted to 35°, *viz.*, hy-

grometric thermometer at sun-rise, 57°; meridian temperature in the shade ventilated, 92° (the hygrometric thermometer being now 66°.) Lowest point of the hygrometric thermometer, 53°; highest, 70°. Greatest degrees of dryness, corresponding to a low point of the hygrometric thermometer, $66° - 54° = 12°$. Greatest degree of dryness, corresponding to a high point of the hygrometric thermometer, $89° - 70° = 19°$. Mean dryness in the morning, 7°; at noon, 14°.

I make no doubt, that greater degrees of dryness occurred at inland situations, visited by me in course of journeying; but instruments were not at hand to verify the surmise, and the minimum of humidity actually observed has barely amounted to a fourth of the atmosphere's actual capacity for moisture.

At the Cape, during the warm season, although the south-east monsoon predominates, westerly winds are not unfrequent. They are always moist. Now and then a shower falls, or a rainy day occurs, in that tract particularly which lies between the chain of high mountains and the western sea. A fog is often seen, driven from the sea upon the land. Still oftener the summits of mountains, or even half their sides, are shrouded in mist. At these times the indications of the hygrometer commonly, it might perhaps be said invariably, correspond with the elevation of the mist, or cloud, upon the mountains. The degrees of dryness shewn by the hygrometer are just so many as agree with the difference of temperature answering to the actual difference of altitude.

When south-easterly winds blow, they bring from the shallow sea, over bank Lagullas, humidity, which is condensed upon the summits of mountains. It is seen rolling down their western cliffs in volumes of thick vapour; and the elevation at which this is dissipated as it descends, answers precisely to the hygrometric state of the air.

Were marks noted upon the precipitous sides of Table Mountain, at intervals of ninety yards in perpendicular height from the base, the number of such divisions, below the cloud familiarly termed the *Table-cloth*, would correspond with the degrees

of dryness exhibited by the hygrometer: for temperature decreases with ascent of heights, about 1° of Fahrenheit's scale, for every ninety yards of elevation.

This will be made plain by citing an instance. Thus, "on 11th January, 1822, at Cape-Town; temperature, 71°; hyg. therm. 58°; a cloud hanging over Table Mountain, not touching it, but just elevated above the summit. The height of Table Mountain, trigonometrically measured, is 1194 yards; difference of temperature, according to theory, 13¼°; degrees of dryness observed, 13°.

"So, on 15th January, at the foot of Table Mountain, temperature in the shade during the whole day, (6 A.M. to 4½ P.M.), 70° to 71°; hyg. therm. 59°; wind S.E., strong breeze; cloud on T. M.

"Noon, at an elevated station, upon the acclivity, above the highest inhabited spot, temperature in wind and sunshine, 69°; hyg. therm., 58°. At a station still more elevated, above the highest plantations of the silver-tree, (*protea argentea,*) temperature, in ventilated sunshine, 68°; hyg. therm., 58½°.

"The wind blowing in puffs and gusts, the temperature is depressed ½° to 1°, when strong gusts blow.

"A dense white cloud on the back of the mountain, receiving evidently continued accession. The vapour passing over the summit, and scarcely descending a little down the cliff, seeming to curl laterally and vertically, and pause while vanishing, as it quits the mountain; sometimes a very small fleece; often more considerable and denser.

"A small detached cloud shows itself here and there, remains a while, and then gradually vanishes; one, over the signal-post on the Lion; another, in front of Camp's-bay; another again in the distance, over Tigerberg; all apparently upon the same level with the cloud hanging on Table Mountain."

The degrees of dryness here indicated, *viz.*, 11° to 12°, agree nearly with the elevation of the cloud, between one and two hundred yards less than that of the mountain.

It can scarcely be necessary to remark, that such hygrometric

observations should be taken as near as may be practicable to the mountain. At the distance of a mile or two, a different degree of dryness may be found.

A mountain, being colder than the plain below, condenses, and renders visible the passing vapour, whenever the dryness of the wind is less than the difference of temperature between its summit and base. Owing to radiation, the influence of the mountain's summit extends to the column of air over it, and a cloud at rest is accordingly often seen suspended high above.

The heat of the plain has a like influence on the atmosphere over it, and affects the temperature immediately above. The vapour then, as it quits the mountain, passes into a warmer region, where it is dissolved, and which thus it traverses, transparent and invisible, to be again condensed, and made apparent on approaching another mountain.

This, as I conceive, is the simple explanation of the appearances which are so conspicuous during the continuance of a strong south-east wind at the Cape. Volumes of vapour are seen rolling over the summits and down the sides of Hanglip, Hottentots' Holland, and the rest of the chain of high mountains. Above the valleys, and over the isthmus, scarcely a passing cloud is seen. But the vapour is thickly condensed on the peninsular group of mountains, rolls over their summits, descends to a certain distance down the cliffs, and is dissipated and becomes transparent as it passes onwards.

The wind, fed by cold and damp, descending from the mountains, blows with great violence, approaching to tempestuous force. But it is partial, and extends to no distance from the shore. It is the boisterous rush of colder air, to replace warmer, in a fervent atmosphere, over an intensely heated land. On the windward brow of the mountain, the breeze is moderate; on the lee side, the blast is strong; at sea, a mile from the shore, there is calm.

In fact, both the south-east and the west winds are, to the promontory terminating South Africa, sea-breezes; and the south-east wind has not parted with that character in a short and rapid passage across the promontory. The parched earth

cannot but be refreshed by the passage of such humid air over it. Its heat is mitigated, or that of the atmosphere above it is so, by cool breezes, which descend from high mountains, bringing humidity recently fetched off the sea.

In a former visit to the Cape, while attentively observing the striking phenomena of the cloud on Table Mountain, during a south-east wind, I fell upon some speculations regarding visible vapour, to which I shall now advert.

To preserve their connexion, some remarks are here repeated, which have been noticed in reference to a different subject in another place.

I consider every stationary cloud, whether hanging on a mountain, or elevated in the upper regions of the atmosphere, as consisting of transient vapour, of which it receives accessions on the one side, and parts with the same on the other; it is vapour visible during its passage through a circumscribed space; transparent before it reaches that place, and again after traversing it. A cloud in motion may, like a volume of smoke, be composed identically of the same vapour, continuing in progress until finally dissipated. But a cloud at rest is, as the smoke of a chimney, a continuous object viewed from a distance, yet transient, seen from a nearer point of view.

The cloud, which, during wind, hangs upon a mountain's summit, certainly is so, as may be distinctly observed on a near approach. Vapour is continually passing over the summit and down the cliffs, becoming gradually attenuated, and vanishing into thin air, as it quits the mountain.

Such, likewise, are clouds which appear immediately over a peak, at a certain elevation above it. A cloud suddenly shews itself, increases for a while, varies its form, yet remains in its position, (though the wind blow strongly,) and at length wanes, and finally vanishes, without change of place.

This is often seen above lower mountains, in the vicinity of a loftier one, which, at the same moment, is enveloped in mist. The clouds suspended above inferior peaks, and the mists which cover the higher summits, are manifestly level, maintaining themselves at uniform height, and clearly marking diversity of

temperature in atmospheric columns, and uniformity of hygrometric condition of atmospheric strata. The column of air has a different degree of heat, according to local circumstances, and particularly the radiating influence of the base from which it rises. Humidity, as it diffuses itself, tends to the same altitude for equal degrees of moisture. Vapour, then, is manifested wherever an atmospheric stratum, containing the proportion of moisture, condensible by a certain temperature, is intersected by a column of air which has that temperature at the elevation of the stratum.

Clouds at rest, while the wind is blowing with violence, are frequently to be seen over False-Bay, and likewise over the isthmus, or *Cape-downs*, precisely similar to clouds suspended over peaks. Generally, during a south-east wind, the sky is clear between Hanglip and Table-Mountain. But now and then a small silvery cloud suddenly appears above the sea, or the shore, grows, changes shape, without change of place, (though the wind meantime continues to blow most violently,) wastes, and vanishes. The phenomenon is singularly beautiful, when the tints of the setting sun play on the evanescent clouds. It often arrested and riveted my attention. I have observed it when the cloud has been low, and at no great distance from the spot where I stood, and I could distinctly perceive the fleeting nature of it.

By analogy with these, and with clouds at rest above mountains, I conclude that the fibrous and fleecy clouds, which are highest in the sky, are as changeable in substance as persistent in place. It is remarked that the *mare's-tail* and *mackerel-backed* sky (as they are familiarly named), and other less noted modifications of *cirrhus* and *cirrhostratus*, which occupy the most elevated position in the sky, alter their shape continually, and exhibit much internal commotion, every speck seeming to be agitated and every part undergoing transformation, while the mass or aggregate scarcely changes places. This agrees with observed facts concerning the mountain-cloud, the *table-cloth* of South Africa. And detached clouds at rest, near mountains, or over them, have likewise the characteristic appearance of

cirrhus, in all respects but elevation and extent. The inference is, that in their structure and nature they are alike.

The periodical winds of South Africa are deducible from the trade-winds of the ocean.

In the southern Atlantic, at the extremity of South Africa, the winds are periodical, consonant during summer to the south-east *trade*, which constantly blows on each side of the promontory; but conforming in winter with the western wind that prevails at all times in the southern ocean. In other words, the fluctuating boundary of the western current of air touches upon the extremity of the African continent in winter, and recedes from it in summer.

It is this alternation of easterly and westerly winds, or of a south-eastern and a north-western monsoon, that determines the climate and seasons of the Cape of Good Hope. But the alternate monsoons of South Africa are confined to its extremity. The western wind touches upon a small portion of the continent, near its termination. Beyond that is the domain of perpetual south-eastern winds over the seas on either side, and the intermediate tract of land is unrefreshed by rain, or by northern winds which should bring it, and presents a parched desert.

The interior of South Africa, according to the testimony of every person who has visited it, is arid in the extreme.

Short of that barren tract, the *Karroo* plains, with a soil capable of fertility, were it watered, are steril for want of seasonable rain. They occupy the middle of the colony of the Cape. Encompassed by high mountains, they receive no benefit from the humidity which western winds bring from the Atlantic, or southern from the Indian ocean, or, without looking so far for its source, from the shallow sea over the Lagullas Bank. The moisture of those winds is intercepted by a double chain of lofty mountains. The barrier is continuous; and wind that passes over the summit of the western chain, has been stripped of its condensible moisture on the eastern side, and furnishes neither rain nor mist to supply a rivulet or a fountain on the inland side. Now and then a thunder-storm occurs, accompanied with hail, or with summer rain; and the only refreshing

showers which the *Karroo* plains receive are due to such partial storms. Shepherds, who depasture their flocks at certain seasons on those plains, watch for the appearance of lightning, and migrate towards the quarter where it has been seen.

On the other hand, the western districts of the Cape, lying between the mountains and the sea, within the limits to which the western monsoon extends northward, enjoy abundant rain in the winter months. The north-west wind arrives from the sea, surcharged with vapour, and parts with moisture as it passes over land cooled in winter below the temperature of the sea, and is further sifted of its humidity as it approaches mountains still colder.

Rain descends copiously, but it is only for a short season; and frequently too short. Autumnal showers often fail, and the harvest of wheat is deficient accordingly. Other sorts of corn, sown earlier and reaped sooner, are less apt to disappoint the husbandman.

Concerning the precise quantity of rain which falls in common years, and at divers seasons, as ascertained for any one station in South Africa, information is wanting. No observations appear to have been yet made to determine this interesting point of meteorology. Pluviometers, kept at various stations, below the mountains and upon them, on the inland side of the great chain, and on the sea-side, upon the western coast and on the southern, would afford instructive results, connected with practical questions, no less than with views of science.

In regard to barometric pressure, this appears from the meteorological diaries, to which reference has been made while speaking of temperature, to be greatest in winter, and least in summer, and the extremes occur in July and January (or February), respectively; that is, in the coldest and hottest seasons. The difference between the mean elevation of the mercury in the barometer at those seasons, amounts to fifteen hundredths, comparing quarter with quarter, and approaches to two-tenths, contrasting the coldest with the hottest month. The extreme difference between the greatest elevation in winter, and least in

summer, approximates to one inch, which seems to be the limit of the range of the barometer at the Cape of Good Hope.

The utmost diurnal variation which is noticed occurred with a hurricane, in January, 1821; the mercury in the barometer descending four-tenths of an inch shortly before the storm, and rising six-tenths at its termination. The range of fluctuation within a day rarely exceeds one-tenth of an inch, and scarcely ever reaches two, unless attendant on tempestuous weather, as in the instance above-mentioned, when it doubled that quantity.

Ordinary variations of barometric pressure, within the limits mentioned, occur with alteration of diurnal temperature, and with change of the wind's direction, or of hygrometric condition of the air. The barometer commonly rises on a shift of westerly to easterly wind, and conversely falls with a return of it to the western quarter; that is, the mercury ascends with a dry wind, and descends with a damp one, which is but saying in other words, that it rises with a dry atmosphere, and falls with a humid one. It does so, when a change of temperature does not interfere; but depression of temperature is very generally co-ordinate with a rise of the barometer, and increase of it with descent of the mercury. When both causes co-operate, cold with dryness, or humidity with heat, the effect may be expected to be greatest, and least when the predominant cause is modified by a less efficient one in opposition to it: dryness by heat, or cold by damp.

It must, however, be acknowledged, that, on a cursory examination of the diaries referred to, the changes there registered are not always to be so daily accounted for. It must likewise be admitted, that the variation of barometric pressure is scanty for difference of temperature, as its assignable cause, and large for difference of humidity.

At the Cape it is in the coldest, though dampest, season, that the barometer stands highest.

ABSTRACT of a METEOROLOGICAL DIARY, at CAPE-TOWN.

	BAROMETER.					THERMOMETER.				
	1818.	1819.	1820.	1821.	Mean.	1818.	1819.	1820.	1821.	Mean.
January .	. .	30.21 30.09 29.76	30.25 30.11 29.9	30.3 30.19 29.6	30.13	. .	96 — 76 $77\frac{2}{3}$ 78 — 63	94 — 75 $74\frac{7}{8}$ 78 — 58	86 — 74 $75\frac{1}{4}$ 72 — 64	76°
February .	. .	30.1 30.05 29.98	30.1 30.08 29.94	30.3 30.21 29.98	30.11	. .	94 — 76 $78\frac{1}{2}$ 89 — 69	94 — 78 $77\frac{2}{3}$ 76 — 58	92 — 80 $80\frac{1}{4}$ 84 — 72	79°
March . .	. .	30.25 30.12 29.96	30.36 30.21 29.94	30.34 30.22 30.	30.18	. .	92 — 74 $72\frac{2}{3}$ 65 — 56	93 — 70 $76\frac{1}{3}$ 62 — 64	68 — 60 $75\frac{1}{2}$ 76 — 68	75°
April . .	. .	33.52 30.10 29.86	30.26 30.13 30.	30.52 30.185 29.7	30.14	. .	83 — 64 64 64 — 52	84 — 66 $72\frac{7}{8}$ 67 — 62	80 — 69 $64\frac{3}{4}$ 64 — 60	67°
May . .	. .	30.4 30.17 30.	30.52 30.19 30.09	30.44 30.27 30.1	30.21	. .	66 — 63 64 66 — 50	78 — 68 $60\frac{2}{3}$ 60 — 54	78 — 63 $60\frac{1}{2}$ 61 — 57	62°
June . .	. .	30.3 30.08 29.6	30.4 30.19 30.01	30.6 30.295 30.3	30.19	. .	67 — 53 $55\frac{3}{4}$ 60 — 48	72 — 5 $59\frac{1}{2}$ 59 — 50	71 — 61 $57\frac{2}{3}$ 54 — 52	$57\frac{2}{5}$
July . .	. .	30.43 30.23 29.8	30.65 30.27 30.	30.5 30.35 30.1	30.28	. .	70 — 55 $56\frac{2}{3}$ 66 — 51	73 — 57 $57\frac{2}{3}$ 56 — 50	66 — 93 $57\frac{1}{4}$ 55 — 53	$57\frac{1}{3}$
August .	. .	30.52 30.25 30.09	30.35 30.26 30.05	. .	30.25	. .	70 — 55 $60\frac{1}{2}$ 66 — 51	67 — 53 $58\frac{2}{3}$ 60 — 50	. .	60 ?
September	30.4 30.17 29.99	30.43 30.23 29.9	30.45 30.25 29.95	. .	30.22	86 — 76 67° 65 — 48	72 — 45 $58\frac{1}{2}$ 60 — 50	75 — 60 $63\frac{2}{3}$ 63 — 53	. .	63°
October .	30.4 30.21 29.92	30.32 30.19 29.9	30.54 30.26 30.	. .	30.22	86 — 65 60° 71 — 48	82 — 60 $64\frac{2}{3}$ 63 — 80	80 — 67 65 63 — 55	. .	63°
November	30.22 30.13 29.96	30.47 30.19 29.94	30.5 30.27 29.99	. .	30.2	94 — 71 71° 68 — 56	95 — 75 $73\frac{3}{4}$ 66 — 55	90 — 83 76 80 — 65	. .	$73\frac{1}{2}$
December .	30.2 30.15 29.92	30.27 30.11 29.9	30.37 30.21 30.	. .	30.16	92 — 72 76° 86 — 64	92 — 63 $72\frac{3}{4}$ 76 — 55	87 — 68 $76\frac{1}{5}$ 81 — 65	. .	75°
Mean . .	. .	30.15	30.2	. .	30.18	. .	$66\frac{2}{3}$	$68\frac{1}{4}$	. .	$67\frac{1}{3}$

Note on the preceding Essay, and on Meteorological Observations on the Atlantic, p. **115** *and p.* **241.**

Comparative trials made in the Laboratory of the Royal Institution, with Mr. Daniell's hygrometer, and the hygrometer by evaporation, have satisfied me, that the stationary point of this last instrument is short of the dewing point. It becomes necessary, therefore, to correct the tabular diary (p. 134, et seq.), by substituting in the sixth column the head of 'Hyg. Stationary,' in place of that of "Deposition of Dew," and to make the like change in the text (p. 117—119.)

From observations with the hygrometer by evaporation (the dewing point being deducible from them), both the actual tension of vapour and quantity of moisture present may be computed.

The following abridged table will serve to shew the correct point of dew, answering to observed depression of temperature by evaporation. The degrees of dryness in the seventh column of the tabular diary (p. 134, &c.), must be increased accordingly.

Table, shewing the Dewing Point inferred from the Hygrometer, by Evaporation.

Temp. Atmos.	Hyg. Evap.	Dew.	Temp.	Hyg.	Dew.	Temp.	Hyg.	Dew.
86°	85	83.1	70°	69	67.8	50°	49	48.3
	84	80.2		68	65.5		48	46.5
	83	77.3		—	—		—	—
	82	74.25		62	51.8		45	41.
	81	71.15		—	—		—	—
	80	68.		56	33.3		41	33.2
	79	61.7		55	30		40	31.2
	78	61.2	65	64	63.	45	44	43.4
	77	57.5		63	61.		43	41.8
	76	53.5		..	—		—	—
	75	49.2		58	49.5		40	36.7
	74	45.		—	—		—	—
	73	40.6		52	33.9		38	33.1
	72	36.		51	31.		37	31.3
	71	31.2	60	59	58.1	40	40	39.4
80	79	77.4		58	56.2		39	37.7
	78	74.8		—	—		38	36.4
	—	—		53	45.7		37	34.5
	72	57.2		—	—		36	32.9
	—	—		48	31.		35	31.3
	66	35.		47	31.2			
	65	30.6	55	54	53.2			
75	74	72.6		53	51.4			
	73	70.1		—	—			
	—	—		49	43.1			
	67	54.2		—	—			
	—	—		44	32.8			
	61	31.4		43	30.5			
	60	30.4						

Art. II. *Letters relating to* Mr. Champollion's *Discoveries in Egyptian Literature.*

Letter I. To William Hamilton, Esq., F.R.S., H.M, Minister Plenipotentiary at the Court of Naples.

My dear Sir, *Paris*, 29*th Sept.* 1822.

* * * I have found here, or rather recovered, Mr. Champollion, junior, who has been living for these ten years on the Inscription of Rosetta, and who has lately been making some steps in Egyptian literature, which really appear to be *gigantic.* It may be said that he found the key in England which has opened the gate for him, and it is often observed that *c'est le premier pas qui coûte;* but if he did borrow an English key, the lock was so dreadfully rusty, that no common arm would have had strength enough to turn it; and in a path so beset with thorns, and so encumbered with rubbish, not the first step only, but every step, is painfully laborious; especially such as are retrograde; and such steps will sometimes be necessary: but it is better to make a few false steps than to stand quite still. If Mr. Champollion's latest conjectures become confirmed by collateral evidence, which I dare say *you* will not think impossible, he will have the merit of setting the chronology of the later Egyptian monuments entirely at rest. Beginning with the few hieroglyphics to which I had assigned a "phonetic" signification, he found reason to conclude that, in the days of the Greeks and Romans at least, a considerable number of different characters were employed for expressing hieroglyphically the letters composing a foreign proper name; the initial letter only of the Egyptian name of the object being denoted by the character; so that the names intended become a sort of acrosticks, or rather acrolexics; and the writing, instead of syllabic, as it may have been in older times, became strictly alphabetical, though somewhat vague in its orthography. Besides the names of Ptolemy and Berenice, which he reads as I have done, though with some slight alterations, and with several varieties of form; he makes out, with more or less latitude, those of Alexander, Arsinoe, Cleopatra, Caesar, Autocrator, Sebastus, Tiberius

Nerva, Trajanus Germanicus Dacicus, and Antoninus; all these principally at Philae: on the Pamphilian obelisc, which I had condemned as a Roman *forgery*, Domitianus and Vespasianus; and on the Barberinian, Adrian, and Sabina. The names on the zodiac of Denderah, with which the French astronomers still persist in amusing themselves, he reads, if I recollect rightly, Caesar Autocrator. If only one or two of these names should be well authenticated by the authority of a Greek inscription, the thing would be sufficiently established for every useful purpose: and at any rate, Champollion has displayed great ingenuity in the investigation. This morning only, he was showing me a particular form of the s, which I told him I thought was like a syrinx or a hand organ; he acknowledged the resemblance, and then observed that the Coptic word for a flute or pipe is SEBI, which agreed exactly with his system. The name of Cleopatra he gets from Bankes's obelisc of Philae; and he has been so fortunate as to discover a collateral document of the highest importance, which gives him that name in the enchorial character. Casati, an Italian speculator, has lately brought over four or five manuscripts on papyrus, all Greek, except one, which is exactly in the character of the second inscription of Rosetta, and the introductory part of which exhibits a date with the names of the sovereigns and of the chief priests, in a form perfectly intelligible, abundantly corroborating the interpretation of the similar passages of the Rosetta stone. These manuscripts are already secured for the king's cabinet; and they are of so much the more value, as they lessen the impatience that one naturally feels to obtain a copy of the inscription of Menouf, which Drovetti keeps locked up at Leghorn; not without something like disgrace to himself and to the nation that he represents. I have been told that a cast of it is in Paris, taken when the French were in Egypt; but the inscription is so much effaced, as to render any ordinary cast of no great value. Another observation, in which Champollion has had the advantage of me, is that of a broken obelisc from the collection of the Duc de Choiseul, exhibiting six or seven of the months, followed by numerical characters indicating the days; although he has not

yet made out which are the months represented by the respective characters. He has also been so fortunate as to discover a mummy manuscript, in which some of the chapters are distinguished by numbers, inserted in the first line of each: they confirm and complete the series, which I had before collected, from various documents, in the enchorial character.

You will easily believe, that were I ever so much the victim of the bad passions, I should feel nothing but exultation at Mr. Champollion's success: my life seems indeed to be lengthened by the accession of a junior coadjutor in my researches, and of a person too, who is so much more versed in the different dialects of the Egyptian language than myself. I sincerely wish that his merits may be as highly appreciated by his countrymen, and by their government, as they ought: and I do not see how he can fail of being considered as possessing an undeniable claim to an early admission into any literary society, that may have a place vacant for his reception. I have promised him every assistance in his researches that I can procure him in England, and I hope in return to obtain from him an early communication of all his future observations.

Of my own I have little or nothing very new to tell you, except that I satisfied myself the other day of what I had long suspected, that our antiquaries were totally mistaken in supposing the character L, denoting year, to be derived from the λύκαβας of Homer, and that it is in fact merely a variety of the hieroglyphical character ꞁ, which is the emblem generally employed in that sense: for I observed on a tablet, which has been let into the base of a statue in the gallery of the Louvre, the first column beginning with the date ∩∩L, "the twentieth year," of King Ptolemy, while another column has the same date, in the form ∩∩ꞁ, as usual. Pray mention this to the Duc de Blacas, with my best compliments. I shall probably be able to send you, in the course of the winter, another number of the "Hieroglyphics," as I do not mean to wait any longer for Drovetti: it is to include some communications from Champollion, and perhaps a comparison of his explanation of the Rosetta Inscriptions with my own; he seems to have been at least more

courageous than I have been, and I sincerely wish that I may be convinced he has not gone a little too fast; but, *Fortuna fortes metuit, ignavos premit:* and I am perfectly prepared to forgive him a great deal. * * * A. B. C. D.

LETTER II. To WILLIAM JOHN BANKES, Esq.

My dear Sir, *Calais,* 21st *October,* 1822.

I cannot more effectually lighten the heavy hours that I am compelled to pass in waiting for the winds and waves, than by employing them in giving you an account of the advantage that has already been derived, to the cause of Egyptian Literature, from the study of the drawings of your great obelisc of Philae, combined most ingeniously, by Mr. Champollion, with the fortunate discovery of a manuscript, among the papyri of Casati, which is written exactly in the enchorial character of the stone of Rosetta. The preamble of this manuscript, which appears to be a deed of sale, or some other legal contract, contains, among the names and titles of the royal family, those of Cleopatra, frequently repeated; and, by setting out from the comparison of this name with the Cleopatra of your obelisc, Mr. Champollion has fully confirmed, and considerably extended, the system of "phonetic" hieroglyphics, which I had conjecturally proposed from the examination of those of Ptolemy and Berenice, though certainly the extension is so comprehensive, as to require some further collateral evidence, before it can be considered as fully established: and such evidence no person is more likely to possess than yourself, since, among the multitude of your Greek inscriptions, of the date of the Roman emperors, there must probably be some few, belonging to the same buildings at least, in which a variety of hieroglyphical names are found, which are interpreted by Mr. Champollion as belonging to the different Roman Emperors, with the epithets *Autocrator Caesar*, or sometimes *Autoclatol Cesal:* for the old Egyptians seem to have been as incapable as their school-fellows the Chinese of distinguishing the R from the L: and hence Mr. Champollion is inclined to believe the Thebaic dialect more ancient than the Memphitic, and to consider ASHILI

as a more ancient form than OSHIRI. I know that you have looked in vain for any well marked coincidence of a Greek and a hieroglyphical name of a Roman emperor, although I believe you were persuaded of the very late date of many of the hieroglyphics in question; but it may be much easier to say yes or no to the truth of a single interpretation, than to decide exactly what the interpretation ought to be; and I hope very shortly to be able to show you such of the names of the emperors, as Mr. Champollion thinks he has made out: I observe, indeed, that some of them are such as I have already noted, from your drawings, as probably belonging to Roman Emperors. It will be natural to look in the first place for that of Adrian on the very valuable and interesting little sarcophagus of "*Phutus*," which has been sent by Mr. Grey to the British Museum: in the cursory view which I was able to take of it, however, I saw no name that could have been so construed, though the goddess Buto, or *Bhuto*, appears as forming a part of the name of the deceased. The "Arsinoe" of the Article EGYPT, according to Mr. Champollion, ought to be read *Autocrator:* I had satisfied myself that it was a name not older than the Ptolemies, and I thought I had reason to call it Arsinoe; and this name *was* annexed to the zodiac of Denderah, though the notable speculators, who have been so well rewarded by the laudable liberality of the French government, found it convenient to *saw off* this most important part of the stone, in order to make it portable: so true it is, that a copy, for the purposes of literature, may be incomparably better than an original transported. The same title appears in great pomp, on one of your tablets, as the object of the respect of a train of deities.

Mr. Champollion has had the kindness to favour me with a tracing of the enchorial papyrus of Casati, a document certainly far more valuable than the zodiac of Denderah; and though I am not at liberty to anticipate its *publication*, I shall venture to amuse myself with sending you a *translation* of such parts of it, as I can pick out without too much trouble.

(1.) SCRIPTUM hoc . . anno . XVI.? Regum Ptolemaei et Cleopatrae suae sororis, filiorum Ptolemaei et Cleopatrae deorum

(2.) deorum . . Beneficorum; et Sacerdote Alexandri et deorum Servatorum, deorum Fratrum . . . deorum Amantium Patris, deorum Beneficorum, dei Eupatoris, et

(3.) deorum Amantium Matris existente; et Athlophoro Berenices Beneficae N. N. et Canephoro Arsinoes Amantis Fratris, et sacerdotissa

(4.) Arsinoes Amantis Patris existente? in Metropoli; et in Ptolemaide? sacerdotibus principibus? Ptolemaei "Soteris" et sacerdote Regis Ptolemaei Amantis Patris

(5.) et sacerdote Ptolemaei Amantis Fratris, et sacerdote Ptolemaei Benefici, et sacerdote Ptolemaei Amantis Matris suae, et sacerdotissa Reginae Cleopatrae, et sacerdotissa

(6.) Cleopatrae filiae regis, et sacerdotissa Cleopatrae Matris . . . insignium, et Canephoro Arsinoes Amantis Fratris existente, in templo

(7.) Principali? Dedit [vel vendidit] . . α . . Chephis?? patre? . . matre? Chene?? . . sponte? secundum? leges . . in templo

(8.) *Intimo?* . . concessit . . βα . . argentum . . γ . . sacerdotes Apidis? in fano

(9.) Nebonenchus? . . quotannis?? in? custodiam? fluminis? . . Chasne? et liberis ejus . . .

(10.) et liberis ejus, hominibus ejus . . . . Chasu? et liberis ejus hominibus ejus . .

(11.) β et liberis ejus, hominibus ejus . . . annua? annona?? animalibus? et liberis ejus, hominibus ejus, in "*Intimo*" . . β . . α . .

(12.) . . γ . . sorores fratresque . . potestatem . . ι (notabiliter?) . . regis . . δ ("2391 . .")

(13.) vestes? . . homines ejus et . . δ . . ejus . . frater? et habitatio . . in argentum . . quotannis? . .

(14.) et . . et . . in . . ι MENSE . . γ

(15.) etiam? sacerdotes Apidis? in fano? "Nebonenchus" . concessere? ejus hominibus potestatem? . . δ . . vestes

(16.) . . ejus . . frater?? et habitatio . . in argentum quotannis? . . ei ejus infantibus aurum omne descriptum argentum annonam? . . .

(17.) . . Scriptum MENSIS Tybi?? xxx . . . ι? . . omne absolvit . .

(18.) sanxit ? ? et β . . et scripsit β . . fausta ? rata ? Pontifices ? deorum Servatorum ? et deorum Maternorum ? et deorum Beneficorum N. N ? deorum Amantium Patris, dei Illustris ? Munifici ? et deorum Amantium Matris : quod sit ratum ?

(20.) Scripsit *Phanres*? sacerdos, pro se . . . Scriba ?

The Greek letters are merely intended to denote some similar assemblages of characters which occur more than once, and which may serve to illustrate the different modes of writing the same words.

Signatures, but apparently not autographs, written transversely.

(1.) Pontifex . . .
(2.) . . . . Jurisconsultus ?
(3.) . . . . filius ? . . . •
(4.) . . . filius ? . .
(8.) Ego ? "Apollonius." Champ.
(13.) Arbasis . .
(14.) Phanul ? . . .
(15.) "Antimachus ; Antigenes." Ch.
(17.) Anna ? et Inha ? ?
(18.) Alii ?

If we had not been previously acquainted with the valuable fragment published by Mr. Böckh, and lately reprinted, with some corrections, obtained from Casati's manuscripts, by Mr. Jomard, it would have been difficult to conjecture that the titles of all the hierarchy would have been inserted in a legal act without their names, the phrase τῶν ὄντων καὶ οὐσῶν being thought sufficient to imply a respect for the offices, although the writer might be ignorant of the individuals occupying them: a circumstance, however, not without analogy in modern times. Mr. Böckh's remarks on the apparent omission of the priests and priestesses, who ought to have followed the priest of Ptolemy Soter, are singularly confirmed by this manuscript.

Believe me, dear Sir, always very sincerely yours,

A. B. C. D.

P. S. By one of those singular coincidences, which only become credible when they have actually occurred, a Greek translation of this deed of sale has this day been placed in my hands by Mr. George Francis Grey. The whole of the preamble is omitted, but the eighth witness is a son of *Apollonius*, and the fifteenth is *Antimachus*, the son of *Antigenes*. The title begins, ΑΝΤΙΓΡΑΦΟΝ ΓΡΑΦΗΣ ΑΙΓΥΠΤΙΑΣ.

London, 22 *Nov.*, 1822.

Art. III. *On certain Elevations of Land, connected with the Actions of Volcanoes. By* J. Mac Culloch, M.D., F.R.S. *Communicated by the Author.*

The geological readers of this *Journal* need not be reminded, that one of the great problems in their science is to determine the nature of the causes whence rocks, once existing beneath the depths of the sea, are now found elevated far above its level. For proofs of the fact itself, we need not have recourse to the observations of Ulloa on the fossil shells found at elevations of 14,000 feet in the Andes, as the whole surface of the earth presents appearances of the same nature.

Two distinct theories have been suggested for the explanation of this fact, yet without necessarily involving all the other points which have divided the two leading bodies of geological partisans. By the one party it has been attributed to the subsidence of the sea; the rocks, with their organic contents, remaining in the places where they had been formed: by the other, it has been supposed that the land has itself moved, while the sea remained at rest. In the last party also, there are some who, like De Luc, view all these changes of the land as having arisen from its subsidence into caverns; others who, like Hutton, consider that the effects have been produced by an elevating subterranean force; and a third party, who admit of both these modes and causes of motion.

It must not be imagined that the theory of the elevation of the land is limited either to that system, which is best known by the name of Dr. Hutton, or to himself. It was originally proposed by Antonio Lazzaro Moro, and it has had many supporters among persons who never heard of an Huttonian theory. Nor is it limited to those who assign an igneous origin to certain rocks and certain changes; since it was the opinion of Saussure, than whom no one ever maintained more strenuously that theory which is called the aqueous or Neptunian.

It is not my intention here to enter into a critical examination of these theories. But it will not be irrelevant to remark, that the hypothesis which presumes on a subsidence of the sea,

is singularly deficient in every thing requisite to explain the appearances for which it is invented to account; and that it cannot be reconciled to any thing that we know of the laws of nature. The angular and elevated positions of stratified rocks, and most particularly where they contain large and weighty fragments, could not have been produced by any mode of deposition from water. Neither could their fractures and dislocations. The positions of shells of various kinds in them, are equally inexplicable in the same view. Thus, where tubular living shellfish are now found, it is observed that their positions are always perpendicular to the horizon, and, consequently, to the stratum of sand which they inhabit. In a corresponding manner, empty concave shells must necessarily settle in water with their convexities downwards. Yet when the strata are found in elevated and angular positions, these shells retain that relation to the plane of the stratum which they had when under the water; a sufficient proof of the displacement of these rocks.

The same theory, in assuming a disappearance of water, which must amount in bulk, at least, to the measure of the hollow sphere contained between that sphere which is measured by the least diameter of the earth, supposing it to be spherical, and by the greatest, imagines a case which cannot have existed consistently with all that we know of chemistry, of astronomy, or of the nature of the earth. Such a mass of water could not be destroyed; nor are any receptacles to be found, or even imagined for it. But it is not necessary to say more on this subject.

It remains to adopt some theory in which the land has been moved, or the rocks displaced, while the general mass of the ocean only changed its disposition in consequence of that motion. But, as it is not my intention to enter into the whole of this question, I shall merely state that the elevation of strata by an interior or subterranean force, must be admitted, at least to a share in these operations. The necessity of this is proved by a variety of phenomena which I cannot detail here. That such a force does exist, even now, is proved by the elevation

of islands from the sea by the action of volcanoes, an occurrence which has often happened; and by the more common circumstances that attend these in ordinary cases, as in Italy, America, and elsewhere.

But this volcanic action has been supposed to be trifling and partial, and incapable of being resorted to for the solution of any other cases than those where the process has actually been witnessed, or can be clearly demonstrated. The object of this paper is to shew that it has produced far greater effects than has commonly been imagined, and that some of the most singular and interesting geological phenomena that are known, can be most satisfactorily explained in this manner.

Before describing the two cases which I have selected for examination, I must, however, notice the simpler one of ordinary volcanic islands, as illustrating the more complicated appearances under review. One of the most noted of these lies near Santorini, in the Greek Archipelago. The formation of this, in consequence of a submarine eruption, commenced in 1707, and in less than a year it had attained a circumference of five miles, with an altitude of forty feet. A similar one, of smaller dimensions, was also formed in the same place not long after; and, according to Pliny, Therasia, Automali, and Thia were also thrown up in this neighbourhood in the same way, in ancient times. In like manner, islands have been generated near Iceland, and the Azores, at recent periods; and but a few years are past since a small island, to which the name of Sabrina was given, was thrown up in the neighbourhood of these latter. These events seem to have frequently occurred in the Pacific Ocean; and, though some of these volcanic islands are low, they occasionally obtain a considerable elevation. Ascension seems to be a very satisfactory instance of this nature, though its actual formation has not been witnessed, as in the cases just mentioned; and St. Helena appears to furnish another example of the same nature.

In some instances these islands seem to be entirely formed of stones and scoria, and probably also of lava, thrown out from the volcanic aperture beneath the sea. These, gradually

reaching the surface, become consolidated, partly by their own weight, and partly by admixtures of lava. Thus pumice is so often found floating in the sea, having probably been washed off in these cases, in consequence of its buoyancy. Sabrina, abovementioned, was entirely carried away in this manner not long after its formation, having been composed entirely of light scoria. In all these cases of submarine eruption, flames and smoke have been seen to issue from the sea; marine earthquakes, (if such an expression may be used,) have been felt, and the water has been heated to boiling.

But it is Humbolt's opinion that, in many cases, these islands are principally formed by the elevation of the submarine strata; and this notion is confirmed by a variety of facts, which may be witnessed in volcanic islands in many parts of the world, as in the West Indies, and in those of the African coast. This mode of formation is that which belongs to the cases here to be described, though they have hitherto escaped the attention of geologists, remarkable and interesting as they are. It will be seen that their interest is not merely limited to the proofs which they offer of volcanic elevation, or to the important consequences for a theory of the earth which thence follow, but that they illustrate and explain many collateral points which have been sources of great difficulty to geologists. The first of these cases is that of Italy, and the other is that of the Coral islands.

In the former country there are found some remarkable alluvial deposits, which, as far as observations yet go, have not been discovered elsewhere. Yet, if the theory which I have to offer respecting them be correct, it is probable that they are not thus limited; but that when their true nature and origin is more generally known, they will be found in other countries where similar circumstances are present. It is chiefly with the view of exciting the attention of such geologists as may have an opportunity to pursue this interesting investigation, that I have given to this speculation the publicity of the *Quarterly Journal.*

For the bare facts themselves we are indebted to Brocchi,

who has described them in his *Conchologia Subapennina*, and in his later essay on the soil of Rome. As he has singularly failed in his attempt to explain them, no less than the reviewer of his work in the *Edinburgh Review* has done, I have endeavoured to supply that deficiency. But in so doing I have not presumed to make any alterations in his facts, nor to suggest any other statements of them than those which he has himself made. On the contrary, they are taken rigidly as he has represented them, excepting where, in a few places, the observations appeared deficient; and I have merely proposed to amend them on the principles which he has himself furnished. It is an extreme abuse, and, unfortunately, far too common on the part of geological writers, to determine what an observer ought to have seen. This is a practice which may be made subservient to any hypothesis whatever, and which renders all observation useless; but there is no law in philosophy against the attempt to reconcile the observations of others to general principles, where the observers themselves may have failed in this respect; provided that no liberty is taken with the facts that are given.

The alluvial strata of Italy had been classed by many persons with the tertiary or fresh water formations, and as a simpler race of those which have been ascertained in the vicinity of Paris, and in our own country. This arrangement is evidently improper, and it appears to have arisen from some confusion in the observations with respect to the marine and the terrestrial remains, and from having recourse to an analogy which, on a superficial view, seems sufficiently obvious, but which is inapplicable. A good deal of intricacy does in fact exist. The lowest alluvium is evidently of marine origin, while the upper one is of a terrestrial nature; and the apparent confusion, which has thrown error into the observations, is caused partly by the proximity of the two, partly by an intermixture occasionally produced in more recent times, partly by that singular alluvial rock, the travertino, and in a great measure by the numerous volcanic alluvia, or tufas, which, instead of remain-

ing where they were erupted, have been transported and consolidated by water.

No blame, however, must be thrown on Signor Brocchi; his observations are, on the contrary, highly deserving of praise, as they are generally luminous, full, and well arranged, while they bear every mark of accuracy. It is no small proof of this, that I have scarcely any where found a chasm or uncertainty among them, though deprived of the advantage of re-examining the facts on the spot; while the evidence appears nearly as perfect and as well connected, though made without the advantage of a correct hypothesis, as if, with that theory in my hand which I here presume to give, I had examined them for myself. Had this excellent geologist paid more respect to the theory of his countryman, Lazzaro Moro, the task of explaining the facts which he has recorded would not have been left to another; but our science has long owed him a debt, which his successors, whether in Italy or elsewhere, seem to have been most unaccountably unwilling to acknowledge.

Those who may read these remarks, may probably feel some surprise that the late learned and keen illustrator of the Huttonian theory, who enjoyed the advantage of a personal examination of these appearances, did not come to the same conclusion as I have done; particularly as that conclusion must have appeared to him so valuable for his peculiar views of a geological theory. I do not pretend to account for the omission; though we must remember that the same appearances do not always make the same impression on every one. That omission must not, however, be urged as an argument against the theory which I have here adopted; since, without detracting from the high and acknowledged merits of Mr. Playfair, every geologist is aware, that his exposition of his favourite system is often deficient in known evidence, as it is often also negligent of insurmountable objections.

In stating the facts from Signor Brocchi, I have been under the necessity of making a very severe abridgment; since, in a journal dedicated to original communications, it would have

been improper to have occupied much space in detailing that which is already before the public. It is better to refer the reader to the work itself; and to it all will naturally have recourse, who may feel interested in the subject, and who are at the same time suspicious of the truth of the conclusions which I have attempted to draw. But I must repeat that I have taken no liberty with the statements, as far as I have been able to apprehend their true nature from consulting both the treatises to which I have referred.

For the geographical details of the subapennine formation, I must inevitably refer to the work itself, as they would both occupy too much room, and would also be nearly unintelligible without a map. But it must be remarked, in a general way, that this deposit, as he has described it, is found, not only in many low situations, but forming a range of hills at the foot of the Apennine. Occurring thus in various places which I shall not enumerate, it is found, among others, in Piedmont, near Parma in Placentia, whence it extends all along the north side of this ridge to Otranto; while, on the south side, it skirts the elevated land in a similar manner, occurring at Orvieto, Rome, near Terracina, and elsewhere. I must also remark, that the same alluvia are to be seen near Vicenza and Verona, or at the foot of the Alps, as well as the Apennines; so that the term subapennine has not been very well chosen.

By putting together Signor Brocchi's facts, it is indeed easy to see that nearly the whole promontory of Italy is more or less covered by this interesting and remarkable deposit; that it does not necessarily form hills, and that it is deficient, only where its deficiencies may be accounted for, either by the waste of the superficial parts on the higher ridges of the fundamental mountains, and their consequent removal; or else by volcanic eruptions and earthquakes; or lastly, by the action of rivers, which have either washed it away, or have covered it with other alluvia of the usual recent terrestrial origin. It is important here thus to generalize these geographical facts, for which the materials have been furnished by the author.

The general alluvial deposit under review, as given by Signor

Brocchi under a common term, consists of two beds, and it is highly essential to distinguish these where they are regular; because, as they are in some places much confused, they have been sometimes described in a careless manner, as if this was a part of their natural character. It will soon be seen that this confusion is the result of posterior, and sometimes of recent, causes. Where they have been described in this loose and general way, they have been said to consist of marl, sand, and gravel, together with sandstone and occasional breccias, containing further various marine and terrestrial remains. In a general sense, the beds may be considered horizontal, or rather as placed at low angles; and they are, consequently, unconformable, under the usual variations, to the inclined calcareous strata of the Apennines on which they lie.

The marl bed, which is the lowest, is, in some places, of an argillaceous nature; in others, argillo-calcareous; besides which it often contains mica. As it is sometimes wanting, the upper bed, which consists of sand and gravel principally, occasionally rests immediately on the solid and fundamental limestone. This lowest stratum is the repository of different mineral substances, such as the sulphats of lime, strontian, and barytes, flint, quartz crystals, pyrites, bog-iron ore, sulphur, and bitumen. Salt springs also rise out of it, and it occasionally gives vent to hot water and sulphuretted hydrogen; phenomena arising probably from the vicinity of volcanoes or volcanic materials.

To describe the upper bed more particularly, it consists of siliceous or siliceo-calcareous sand and gravel, often containing mica and yellow ochre, while in some places, as at San Marino and Volterra, it becomes a solid sandstone. It does not every where cover the marl bed, being occasionally deficient. This deposit, it may be added, is sometimes accompanied by the partial breccias just noticed, consisting of fragments of the older rocks, and occasionally containing shells.

If we take both these beds together, as Brocchi has sometimes done, from not seeing the value of the distinction, the organic remains contained in them exhibit great confusion of

origin. They comprise numerous marine objects, consisting of shells and fishes; but these are far more abundant in the marl than in the sand, while very extensive tracts of alluvia are found without any. The shells are said to be sometimes similar in both beds; but it is very important to remark, that where they abound, they are found associated in families; a proof that they have not been transported, but that they now lie where they were originally produced.

Some of these animals, it must now be observed, are admitted to exist in the present seas of Italy, while others are supposed to be exotic or else unknown. Thus a great deal of additional obscurity has been introduced into this subject, which it is important to remove. As I cannot here however go into any great length of detail in this point, I must content myself with the case of Monte Bolca, as the most conspicuous example of erroneous observation and reasoning.

In this hill, the fishes are found in a marly slate, which is part of the lowest or marine bed, called by Brocchi subapennine. This substance does not lie in continuous strata, but in distinct and detached masses among the looser materials. The forms of these animals are well defined, particularly in the harder parts. The animal matter is indurated and mixed with the including earth, is of a brown colour, and is further, at times, so thick as to project from the stone, and to admit of being separated. This part is brittle and glossy, so as somewhat to resemble glue, but the bones are sometimes converted into calcareous spar.

With respect to the species, Volta, with a very imperfect knowledge of ichthyology, has thought fit to give names to one hundred and five, and has performed this task most incorrectly. Moreover, prejudiced in favour of some marvellous and mysterious revolutions of the globe, and like many other geologists, preferring an impossible solution to an obvious one, he has referred his imaginary species to various distant places of birth or habitation. Thus he begins by pointing out seven fresh-water fishes, as if he had not created difficulties enough without that; whereas Blainville, with an accurate knowledge of this

subject, has decided that there is not one, but that they are all marine species. His testimony cannot be suspected of any bias, as he has no geological theory to serve, and has indeed committed this very error himself in the case of the petrified fishes of Oeningen. Among the remainder, Volta decides, generally mistaking either the genera or the species or both, that twenty-seven are European fishes, and thirty-nine Asiatic; that three belong to the African coast, eighteen to South America, and eleven to North America. Blainville very properly doubts this determination, on ichthyological grounds; and there need be no hesitation in saying that, on geological ones, it is impossible.

If the theory of Italy which I have to propose be correct, these should all be fishes that either reside now, or did once reside, in the Mediterranean; as there may be lost fishes as well as lost terrestrial animals. Accordingly, it is remarkable, that nearly all those which are so perfect as to admit of no dispute respecting their characters, are Mediterranean fish at present. Many specimens are so imperfect that it is impossible to decide on them; and Blainville, who is by no means wanting in good will towards the formation of species and genera out of imperfect fragments, has reduced the 105 to about 90. It is most evident, that a great part, even of this number, is founded on the most random conjectures. But enough of Monte Bolca.

Besides the more common marine fossils, there are found the bones of whales and dolphins; and even entire skeletons of this nature have been discovered at elevations of 1200 feet above the sea. It is further remarkable, that the bones of the whales have been found incrusted with oyster-shells, and that they are almost always in a state of high preservation; a proof that they have not been brought from a distance, and a farther one that these are not transported alluvia.

The terrestrial remains are generally found a few feet beneath the surface, and are therefore commonly in the sand or gravel, or in the upper bed; but as that bed is occasionally absent, they also occur in the marl. They consist of the bones of the hippopotamus, elephant, rhinoceros, mastodon, urus, and elk,

together with the horns of stags; and to these must be added vegetable remains, consisting of the trunks and fragments of trees, together with leaves but little altered, fresh-water shells, and, lastly, fragments of travertino, or alluvial rocks, and vegetable calcareous incrustations, resembling those which are daily formed in situations where solutions of carbonat of lime flow.

Besides these two remarkable beds, there are found, in many parts of Italy, superficial strata, some of which are peculiar to itself, while one is common to all countries. This last is the ordinary alluvium of rivers; such as that of the Po and the Adige to the northward of the Apennines, and that of the Tiber to the southward. Those which are peculiar to it, are the solid calcareous alluvial rock, called travertino, loose tufaceous matters of the same nature, and volcanic tufas. The plain of Sarteano, the Maremma of Tuscany, the Solfatara, and the vicinity of Rome, offer examples of these strata. The calcareous substances sometimes contain fresh-water shells and vegetables; nor are these always absent from the volcanic tufas.

Hence arises a confusion which requires to be explained, because it has very much obscured this subject. In his last work on Rome, Brocchi has cleared up some circumstances which he had not explained before; and it will shortly be seen that there is no difficulty in explaining the whole, and in simplifying the facts, merely by approximating and comparing them.

The chief confusion, in this part, consisted in the transportation of the volcanic substances, and in their cementation by means of the calcareous waters which flow from the Apennines. In consequence of this they sometimes contain matters, the presence of which would otherwise be unaccountable; such as vegetables, and land or river shells. In the same way they alternate, or are strangely and irregularly intermixed, with the travertino and the loose alluvia of the rivers; while they are also found in places far from the vicinity of recent volcanoes, or from even the suspicion of ancient ones.

It is easy to comprehend the fallacies that must have arisen

from misapprehending the real nature of these appearances. When also an opinion of their unintelligible derangement had once been adopted, much more confusion than was actually present was supposed to exist, where a little attention would have solved all the imaginary difficulties. Had Brocchi originally proceeded on a proper theory, there is little doubt that he would have found every thing easy, and have rendered it equally so to his readers.

According to this author, similar shells are sometimes found in both the alluvial beds; but it is moreover stated in a general way, that the more conspicuous marine remains occur in both. Yet, at the same time, it is said, and in a much more decided manner, that these are far more numerous in the marl bed than in the arenaceous one, and that the shells occur in colonies, just as they lived in the sea. It is also remarked, that the marine remains bear no marks of transportation; and further, that the terrestrial ones are generally found a few feet only beneath the surface, and in the upper bed; although, when that is absent, they occur in the lower. As that which I have undertaken to prove is, that the lower, or marl bed, is a marine alluvium, and the upper a terrestrial one, it is necessary to try to reconcile these anomalies, as well as that which consists in the confusion among the volcanic tufas and the alluvial substances.

The entire absence of all organic remains requires no explanation. Where the terrestrial alluvia are wanting, the organic substances that would otherwise be found in them, must necessarily appear to lie in the marine or lower stratum, however slightly covered or truly superficial they may be. Though found somewhat deeper, it is not difficult to understand how this might happen, as well as how the marine remains may occasionally occur in the upper alluvia. Revolutions of the surface, and principally from partial transportation by rivers, must inevitably have generated much confusion of this kind, capable, even in the hands of a good observer, of misleading him in his conclusions, unless previously on his guard to distinguish appearances, which, even then, are often difficult to dis-

criminate. Occasional marks of transportation might easily be overlooked over an enormous space, where the principal facts were of a different nature; as these latter would form a sort of standard for the whole, and would naturally lead to a neglect of such petty variations as seemed to be uninteresting. But geologists accustomed to investigation, are sufficiently aware of the ease with which errors of this kind are committed (particularly where no theory is present to point out what, appearing trifling, is truly essential) to feel no surprise at oversights of this nature, even in such a geologist as Brocchi.

That I may not, however, prolong this examination too far, I shall merely suggest two circumstances more, which may easily prove sources of error in reasoning about these Italian alluvia. It is far from certain, that the two beds can every where be distinguished, merely by their natures, exclusively of the remains which they contain. A sandy stratum must in some places have formed the bottom of the sea, as well as a muddy or marly one. Thus the marine alluvium may easily be confounded with the terrestrial one; beds of alluvial matter, not admitting of that separation which so generally marks different solid strata, even where the nature of the two beds in contact is the same. This is sufficiently obvious. It is also matter of notoriety, that volcanic eruptions and earthquakes have produced great confusion, even in recent times, in many parts of the surface of Italy; and when we consider the great number of ancient volcanoes in that country, sixty craters remaining in a very small tract, we need be at no loss in assigning abundant causes for disturbances and anomalies in the appearances of the superficial strata.

It is detracting nothing, therefore, from the merits of the Italian geologist to criticise his remarks; nor are his facts perverted, when they are thus rectified on acknowledged and obvious principles. The view here entertained of their real bearings is indeed amply confirmed by the great majority of the facts that are stated in his works; by which the distinction of two strata, one containing marine and the other terrestrial remains, is proved, even by himself. There is little doubt that

had all the local circumstances attending each case observed over so large a tract of country been stated by this author, the present explanation would not have been required; nor would the point which it is my object to prove, have called for this discussion.

That point is, that Italy in general is covered by one marine stratum, in which the organic remains lie in an alluvial bed, untransported and undisturbed; and that above this there lies a terrestrial stratum which contains the remains of land animals analogous to those which are found in most other parts of Europe.

It remains to explain this state of things, or to give a theory of the alluvial deposits of Italy. That theory, if just, ought to be applicable to all similar cases of marine alluvia found high above the level of the sea, should such be hereafter discovered in other places; and it will thus furnish us with a new key for the solution of a certain set of geological phenomena, for which no other branch of any of the general theories provides an adequate explanation. It is important to remark how accurately this partial theory ramifies from the general one, which accounts for the elevation of the strata by a subterranean force; and how valuable a test of any theory it is, to be thus provided with the means of explaining appearances that could not have been anticipated when it was formed. Had Lazzaro Moro taken a wider and more accurate view of the circumstances by which he was surrounded, the present explanation would not have been required.

In investigating the causes of the present positions of solid rocks containing organic remains, we are only enabled to assign them in a general manner, and by analogy, because they have left no positive collateral evidence of their action. This may probably be in a great measure attributed to the great distance of these events in point of time, and to the changes which the exposed surface of the earth has since undergone. In the present case, however, we see the germs of these very submarine strata exposed before their consolidation, and probably presenting the appearances which they do, merely because they are of

more recent date. At the same time, instead of being driven to seek for causes by a circuitous and analogical road, we find these at hand in the general volcanic nature of the country under review, while, in some places, we can almost trace the very cause itself in action.

In different places, and in Italy very particularly, it has been observed, that the relative level of the sea and land is subject to change, and that it has in past times undergone frequent alterations. For the proofs and nature of these, I must refer to Breislak and others, who have examined this subject with considerable care, as I dare not prolong this paper by repeating them. The present case may be considered as an extreme one of that nature; in consequence of which the bottom of the sea, together with its unconsolidated alluvia has been raised above the surface of the water, so as to have become dry land. Thus it is easy to account for the presence of marine remains, as well as for their presence in that singularly undisturbed state which has been described.

It is equally easy to account for the proximity of the marine and the terrestrial remains, as also for that of the alluvia which respectively enclose each. Whatever cause or causes generated the usual terrestrial alluvia that occur all over the world, these have apparently been deposited, in most cases, on naked rock. In this particular one, they have settled on a previous alluvium of a different character, and, as far as our present imperfect observations go, solitary. The apparent interference of the two classes of organic remains follows of course.

If that interference is ever greater, so as to amount to a real mixture or alternation, I have already shewn how it can be explained, by a variety of circumstances, consisting in more recent changes and deposits, and in the imperfection of observations, the real bearings and value of which were not anticipated. But it is proper also to say here, that other causes of a more general nature may have produced the same effects without in any degree vitiating the theory here offered.

It is believed that many of the terrestrial alluvia have been the produce of diluvian currents; and it is impossible, if this

be true, that these should have taken place without disturbing a previous alluvium. Thus the mixtures of the different kinds of remains would be accounted for, even in those cases where they could not be attributed to the modern action of rivers.

Although no real instances of alternation in these alluvia have been brought forward, and as a true one, could not indeed happen, it is also easy to see that such an event might occur upon the same principles which have produced the alternation of marine and fresh water deposits in the basin of Paris, or in the other tertiary formations. It is equally easy to comprehend that, in such a case, a mind unprepared for a proper examination of the appearances, might be led to confound together, things differing in their natures, and thus to throw doubt and confusion into that, which, if rightly examined, would present no real difficulty.

It now follows that the elevation of the land of Italy, which is the origin of these phenomena, is to be attributed to the same causes which are now, or have recently been, operating in producing smaller changes in the relative level of the sea and land, and of course, in elevating the latter. These causes are connected with earthquakes and volcanoes, or are dependent on volcanic action. They are the same that raised Santorini from beneath the ocean, and that have produced the phenomena of the coral islands, which will shortly be described. In the history of these, further proofs and confirmations of these views will be found. Of whatever date these events may be, they are anterior to all history; even to that of the general deluge, if it is rightly judged that any of the terrestrial alluvia were deposited at that period. If a similar occurrence were to take place at present, it is evident, that the submarine alluvial stratum with all its imbedded remains, would exhibit the same appearances as the lowest of the Italian beds does; and that the skeletons of whales should be found at elevations of 1200 feet above the level of the sea, is no more surprising than that they should be found at all.

This particular fact is, however, important, as shewing the vertical extent of this elevation, just as the geography of the

marine remains demonstrates that of its superficial one. For want of more accurate information, we may here take these as Signor Brocchi has given them, for the extreme limits both ways; and thus we can estimate what Italy was before the change, and how much of it has been the consequence of a volcanic elevation more recent than those extensive changes of the same nature which caused and determined the present general distribution of the land.

The extreme height of the Apennines is said to be about 9000 feet, and, on the present supposition, the whole of that chain, from this height down to that of 1200, must be supposed to have formed a ridge rising above the sea. I need not extend these conjectures to the side of the Alps, as the reader can easily pursue these speculations at his leisure. It is probable, that at the period at which modern Italy was produced, the whole of the central chain experienced a fresh elevation to the altitude of at least 1200 feet, and over a superficial space which reaches from Otranto at one end of the country to Piedmont, and to the foot of the Alps generally, on the other side; since the neighbourhood of Vicenza and Verona presents the same appearances.

Others may imagine, if they please, that only those parts were thus elevated which now possess the submarine alluvium; yet this would make no difference in the general views; since that force which was sufficient to move so large a part of Italy might as easily have moved the whole. This is a circumstance that might however be put to the proof, by examining the stratification of the Apennines in a proper manner. Some dislocation or discontinuity in the order of the stratification will be found at a certain elevation, if this supposition be correct; and I may here point out to those geologists who may have an opportunity, the interesting circumstances of various kinds, which still await them in Italy, from the views of the nature of that country which I have here given. Were it of any use to accumulate conjectures, it might even be suggested that the whole of that country, even to the highest point of the Apennines, was raised at one single period from beneath that ocean in which we know that

the limestone of this ridge was formed. Should this have been the case, the absence of the marine alluvium from the higher parts, would be accounted for, on the same principles which are applied to the denudations of the earth's surface all over the world.

Though these phenomena should be quite partial, and if they do not, therefore, possess so high an interest in reality, as the great elevations of the continents, and of the enormous mountain chains of America or Asia, they are of a much more impressive character, from the greater facility with which we associate the causes and the effects, and from the more palpable and tangible nature of the phenomena; from the actual association of an active existing cause, with effects that cannot be questioned. The others, we look coldly at, through the lapse of ages incalculably distant; so distant that they excite in us no personal interest, and so much less obvious also, that we feel rather inclined to doubt, than to admit of conclusions which are attended by consequences somewhat revolting to our narrow experience. In contemplating the others we feel the insecurity of the earth on which we stand, and in every earthquake recollect that what once arose, may again be consigned to the bottom of the ocean.

Before concluding this subject, it is necessary to remind the reader of one collateral circumstance, which is not only interesting in itself, but which strongly confirms those views of the cause of those appearances which I have here held out. That is, the suddenness or rapidity of the action which produced these important events. This might be concluded from the undisturbed state of some of the shells and skeletons already mentioned; but it is still more strongly proved by the preservation of the animal matter in the ligaments of the bi-valves, and by the condition of the fishes of Monte Bolca already mentioned. A noted specimen, now in the collection at Paris, and once appertaining to Count Gazzola, evinces in a singular manner the rapidity of the catastrophe by which these changes were effected; since, in it, one fish appears to have been arrested in the act of swallowing another.

It will not here be superfluous further to observe, that the condition of the fossil fishes of Iceland, seems to throw light on the remarkable deposit of Monte Bolca. These are found at Patrick's Fiord in that country, imbedded in an indurated mud, or marl, and it is said that they are even now in the act of being formed. The fish, in a living state, or perhaps but just dead, seems to have been first entangled in a soft mud, which has been firmly attached to it by means of the animal matter that has mixed itself with that substance; while the harder parts, or the bones and scales, remain unchanged. Thus the nodule that encloses them is first produced, and it remains imbedded in the surrounding materials.

I may now terminate this part of the present subject, as that which follows pursues the same train of reasoning on a different foundation of facts. But I must not quit it without pointing out to geologists, the propriety of examining all the situations analogous to Italy, since the same circumstances respecting the alluvia may possibly exist in many other places. That part of the subject has been entirely neglected; although volcanic regions and volcanic phenomena have been far from deficient in observers. The present case offers an apt instance to illustrate the necessity of previous theories or general views. Without such a guide, these obscure appearances might easily have continued to be misapprehended, so as to have deprived us of a most valuable evidence respecting the changes of the earth's surface and their causes.

It is scarcely necessary to point out the places where such phenomena may be sought for; although, as being the most easy of access, and as presenting the most satisfactory examples of volcanic elevation, I may name the Azores and the other volcanic islands of the African coast, as well as St. Helena, Ascension, and perhaps, Owhyhee. It ought also to be in the perpetual recollection of every geologist, that as all the supra-marine land has apparently been elevated by some causes, from the bottom of the sea, there may be submarine alluvia beneath terrestrial ones, in many countries which shew no traces of a volcanic nature, or of a volcanic origin.

The general importance of this remark must be very apparent. It is quite possible that this may have been the true source of many of the appearances connected with alluvia and with fossil remains of different origins, that have been the causes of so much trouble to observers. It must be remembered, that although all the land be supposed to have been elevated from the sea, it by no means follows, that this was a single event. It is much more probable that it was successive, and that the causes operated through a long series of ages. Hence there may be a chain of intervals in time, connecting the most remote catastrophes of this nature with that of Italy, and uniting even this one with the latest formations of volcanic islands. Among some of these, at least, we might expect to find analogous appearances to those which have here been discussed; as it is impossible to conceive an elevation of rocks which was not accompanied by that also of the unconsolidated submarine materials that chanced to be present. I will not, however, dwell on this suggestion; as I know not of any positive observations at this moment that could be brought to bear on it. Yet geologists must see that they have been somewhat hasty in limiting the causes of alluvia to diluvian operations, or to those more tedious actions which form so conspicuous a part of one of the most noted theories of the earth.

I must now proceed to consider the case of the coral islands, as offering the same proofs of the elevation of submarine strata by the action of volcanic force. These also, which appear to be of dates considerably distant, serve to connect the catastrophe which generated Italy as it now is, with those which, in Pliny's time, formed the Greek volcanic islands, and with the more recent ones, which in our own have produced the new islands of Iceland and the Azores.

The production of the coral islands which are scattered over the great Pacific ocean, which endanger the navigation of the Indian Archipelago, and which, by their daily increase, are ruining that of the Red Sea, is a phenomenon completely distinguished from all the others which are objects of geological investigation. By the silent and almost unnoticed operations of

the minutest animals of creation, the foundations of new lands are daily preparing under the ocean. Nor, as in the case of other submarine formations, are these operations limited to the germs of future and distant continents and islands, and destined only for the habitations of races in the far remote and merely possible future. In consequence of the instincts of these animals, assisted by other causes, which will presently be described, the rocks which they form become elevated above the sea without the necessity of those actions which have raised other submarine strata from below. Thus daily additions are made to the habitable surface of the earth, and islands gradually arise in the wastes of the ocean, enlarging the dominion of man, and promising to unite the remotest continents in the bonds of mutual intercourse.

Independently, therefore, of the proofs which some of these islands afford, of elevating forces connected with volcanoes acting beneath the surface of the earth, the simple fact itself forms an interesting and necessary branch of geological inquiry; and the more so, because it has hitherto experienced unaccountable neglect among geologists. It cannot be less interesting to study the formation of immense masses of calcareous rock, by living animals, than by the accumulation of the spoils of dead ones. It is in many respects even more so; no less from the illustration it affords respecting the ancient calcareous rocks of the globe, than from the tangible nature of what, in these analogous cases, is only matter of inference, and from the apparent feebleness of the agents concerned in the production of these most important effects.

With respect to all the organic fossils, their chief interest is derived from the relations which they bear to the existing species, and from the effects which they have on the structure of the earth. We are surprised at the immense accumulation of shells which form the secondary calcareous strata, or which, if they do not actually produce these, contribute most materially to their bulk, as well as to their chemical nature: and, in examining them, we cannot help being struck with the immense additions which the solid crust of the earth has received from the labours of animals which, employed only in

forming their own habitations, have, in the progress of time, generated mountains ; as we may safely say, when we examine the enormous strata into which they enter as principal and constituent parts.

Still, however, these do not make that impression on us which they ought; because, seeing these rocks as we do, mixed with others, long deserted by the sea and by their former inhabitants, and now divested of all marks of life, and except to the eye of a geologist, of all indications of their former origin, we are apt to pass them by, and think that the surface of the earth might have been nearly the same had these animals never existed, or had they remained at the bottom of that ocean where they lived and died. But when we trace this very act in its progress; when we follow with our eyes the increments which the land is actually undergoing in consequence of the labours of submarine animals, we receive a very different impression respecting their importance; and, in watching the hourly formation and increase of the coral islands, begin to be more sensible of the vast importance of this race of beings, and of the immense changes which all the marine tribes must have produced on the chemical nature, as well as on the structure and disposition, of the superficial or more recent strata.

With respect to the operations of shell-fish, we know that they are now forming immense strata under the waters, just as they must have done in times long past, and before they could have produced the rocks which we now behold above the ocean. Whether these are ever destined to rise above the sea, or when that may happen, we cannot even conjecture; although, were we to reason from analogy derived from past events, we should conclude it was probable, unable as we are to assign the mode in which such an event is to be brought about. Should it happen, new calcareous strata will be found on the surface of some future earth, and the fossil remains of those days will be what were the living species of our own.

But when we examine the operations of the coral animals, we find in them that which we cannot in those of the shell-fish. In

the latter we can only infer from observation and analogy, that the immense masses of our present calcareous strata have been thus produced. We transfer from the bottom of the sea those operations which we know to be daily going on; and, reasoning on them, recur to a time when our limestones were in the same act of being formed, and were preparing for future dry land; land to be laid dry by its own elevation, or by the receding of the waters, as geologists shall hereafter agree or prove. But there is a perfect and complete chasm between the two, at least in the case of marine strata. In the terrestrial or fresh water ones it is otherwise; as we can follow the marly deposit of a lake till it rises to the level of the water, and, gradually excluding it, prepares the dry land; an operation of which every country, and our own mountainous region as distinctly as any, affords daily proofs in the marl deposits, covered with soil and peat, that are found throughout the Highlands of Scotland.

In the coral formation, this chasm, even as to the marine strata, is filled up. Such is the nature of the animals in this case, that instead of spreading their manufactures, if I may use such a word, along the bottom of the ocean, as the shell-fish do, and concealing their stupendous works far beneath the regions accessible to man, their tendency is to seek the surface of the sea. There the huge strata which they produce are brought to light, even during their own and our existence, and we become acquainted with rocks that may be considered as fossil and living at the same time. When once the animals have deserted their habitations, when these have reached, as they do, above the surface of the water, and even far up into dry land, into islands of great extent, they must be considered fossil productions, as much as any other calcareous strata.

It appears that each coral, whatever its species be, is a solid calcareous structure, somewhat resembling a vegetable in the general progress and increase of its parts, inhabited by numerous similar animals, which are precisely the same for each individual coral, but different in the different species. Each of these corals may thus be considered as a colony, the inhabitants being disposed in minute cells, where they reside

and carry on the operation of extending their habitations. In these operations, however independently each seems to act in the production of its own cell, or in the extension of its own immediate neighbourhood, the whole are regulated by some common mysterious principle, by which they all concur towards the production of a structure that would rather seem to have been directed by one mind. Now nothing very analogous to this takes place in the animal creation, except in the case of the gregarious insects, that construct a common habitation for breeding, such as the bees and the ants. In these there is a possibility of personal communication; and that there is such, is proved by the accurate researches of many naturalists. No such communication can take place among the coral animals, because each is fixed and rooted to its cell, of which it forms a part. It may be considered, indeed, that the whole of the colony are parts of the structure which they inhabit, just as flowers are of a plant.

This analogy is very strongly confirmed by attending to the genus *vorticella*, a soft animal, incapable of constructing such a habitation as the coral, yet possessing some very striking analogies to it. The simple *vorticella* is independent, and swims at liberty; not unaptly resembling, at the same time, a flower, or a bud just expanded; appearing to consist of a body resembling a calyx, provided with tentacula, that have been compared to stamina or petals. But if we proceed from the simplest *vorticella* onwards, we find a species which is immoveably fixed, by a pedicle of animal fibre, to the spot where it was produced, or is at least only capable of floating through the water within narrow limits. In further progress, two are united by one stem, and at length there are found one or more species, in which a single stem produces numerous ramifications, each of which is terminated by the calyx-shaped animal, or flower, if we may so call it. In this case, each animal is partially independent, yet all depend on the whole; so that were it not for the demonstration of its being of an animal nature, it might be esteemed a vegetable. In what way this mutual dependence and co-operation of many animals, to

produce a common structure, is managed, we cannot conjecture: but it might be imagined, did we not know the independent and single *vorticella*, that the ramous one was itself but one animal, and that the flowers, or single *vorticellæ*, were only its parts. The whole dependence presents a singular analogy to the vegetable identity, where all the leaves and flowers conspire together to produce and propagate the plant; so as almost to lead us to conclude that there was here a perfect gradation from one department of nature to the other.

This explains the dependence of the coral colony, as far as one difficulty can explain another. The only difference consists in the hardness or softness of the habitation, or tree, if it may be so called. In the *vorticella* it is a soft animal matter; in the coral it is bony, or stony. And here also even the corals present an analogy to those vegetables which, like the chara and the coralline, incrust themselves with calcareous earth, or to the equisetum, which secretes a siliceous bark.

To take the inhabitant of the madrepore as an example of the animal itself, it may be considered as formed of the shell, the head, a centre, and the feet or hands: the latter are very numerous, and are divided or split at the extremities, while they surround the body of the animal in the form of a circle. Each of these feet or hands embraces a lamella of the star of the madrepore, so that they serve both for the construction of the shell, and for fixing the animal in it. The pedicle, or single part of the hand, appears to be of a muscular nature, and is fixed in a cylindrical tube, which is properly the body of the animal. Within this is a stellated body, which is supposed to be the head, quick in its motions; while the rays seems to be the tentacula by which it feeds itself.

The different species of corals engaged in the formation of the coral banks are not all known; but some of the genera, at least, and a few of the species, have been ascertained. The chief of these are madreporæ of different kinds; milleporæ, among which the cœrulea has been discovered; the tubipora musica; a caryophyllia, a distichopora, and a corallina. Astreæ, echini, and other animals, living and dying on the

banks, add to the heap of calcareous matter, without being properly concerned in the erection of the structures. Frequently also, holothuriæ, and other soft worms, are found in the reefs, and have by careless observers been mistaken for the coral animals.

To describe, or even to enumerate, the different islands and rocks which owe their existence to the labours of the coral worms, would be to enter on a wide field of geography. The narratives of many navigators, such as Cook, Kotzebue, Flinders, and others, may be consulted by the reader who is desirous of more minute information on this subject; as it would exceed the necessary limits of this communication, to go into it in any detail. A very brief notice of a few remarkable examples is alone admissible.

Nearly all the islands that lie on the south of the equator, between New Holland and the western coast of America, derive either the whole or a great part of their structure from these animals. The whole of that sea, and indeed of some others, abounds in coral rocks and reefs, which are in a state of daily and rapid increase, and are probably destined at some future day to elevate themselves to the level of the water; to become first the seats of vegetation; and, in process of time, the habitations of man; and perhaps ultimately to produce scarcely less than a continent in this extensive ocean.

Among other places, these reefs abound particularly between New Holland, New Caledonia, and New Guinea; and they are well known to exist in great abundance in the seas of the Indian Archipelago, as at Chagos, Juan de Nova, Cosmoledo, Assumption, Cocos, Amirante, and the Laccadive and Maldive islands. They are numerous also, in the east side of the gulf of Florida; and it is well known that they form a daily increasing impediment to the navigation of the Red Sea.

The extent of these reefs and islands is an object of great curiosity and surprise when we consider the apparent feebleness of the means by which they are produced, and the minuteness of the agents. An instance or two of this must suffice here. Tongataboo, described by Cook under this misapprehended

name, is an irregular oval of twenty leagues in circumference, while its elevation above the level of the water, reaches to ten feet. The soundings, from which the thickness of this bed of rock might be estimated, have not been given, but these are known to be deep throughout all this sea, and may safely be taken at not less than a hundred fathoms; so that the whole forms, what may be considered an enormous stratum of organic limestone. But the largest which appears to have been ascertained is the great reef on the east coast of New Holland, described by Flinders, which extends unbroken for a length of 350 miles; forming, together with others that are more or less separated from it, and from each other, a nearly continuous line of 1000 miles, or more in length, with a breadth varying from twenty to fifty miles. Before such a mountain of limestone as this, even the Apennine almost shrinks in the comparison; and that such a mass should have been produced by such insignificant means, is a just subject of admiration to philosophical minds, and of wonder to those which have not considered the indefinite powers of units in endless addition.

Although the greatest depths of these submarine mountains have not been ascertained, they have been sounded to 200 fathoms and more. It is not uncommon for navigators, to say that they lie in depths that are out of sounding: a vague mode of expression among mariners, as it is now known that the lead can be sent down without difficulty even to a thousand fathoms. The reefs, or the islands which they form, are sometimes disposed in rows, or in lines more or less straight: at others, they are accumulated in groups; and not unfrequently, they are disposed in a circular or oval manner; the latter disposition, whether on the small or great scale, having a material influence on the form and nature of the future island.

It is imagined, that their generation is very rapid; but on this part of the subject there is some uncertainty, while there is also reason to think that it has been somewhat exaggerated. These seas cannot, from their extent, be intimately known; nor is it possible that the infinite numbers of the reefs that exist in them should have been noted down. Even if they had, it is

always an excuse for an incorrect chart, or, as in the case of the Alceste, for a bad reckoning, to assert that a new rock was found where the old one had been overlooked.

On examining the soundings of the seas in which they lie, and on comparing their positions, it appears probable that the various dispositions, as well as the places of the reefs, are in a great measure determined by the forms of the submarine land, and that they are placed on the tops of the hills, or on the most elevated parts of the bottom. When they form straight or curved lines, the side of the submarine structure to windward, or that which is exposed to the breach of the sea, rises almost vertically in the manner of a wall; while to the leeward, they shelve gradually away, so as to deepen the water as they proceed in this direction, when, at the other side they have reached its surface. It is supposed that there is here some design for effecting a purpose which it is thought that accident can scarcely have determined; and that the intention of the animal in thus building up to the windward, was to procure shelter for continuing its productions to leeward. Whatever may be thought of that supposition, it is this abrupt manner of rising from the bottom which renders them so dangerous to ships; as, from deep soundings, they may in a moment be on shore, and almost without warning.

When the groups are circular, there are some peculiarities in them, as well as in the results, which are worthy of notice. A number of detached rocks and islands are first observed, forming a chain, which becomes gradually united in different places, so as to hold out the prospect of its becoming continuous at some future day. All round this, on the outside, the water is deep, and the walls vertical; but within, it is found to shoal in different places, so as to convey the idea of a large platform, surrounded by an elevated margin, with a depression in the middle. In the smaller circles, when this process is completed, the reefs represent a circular basin. This basin continues to be salt, and is a receptacle for sea water for some time, during which it continues to grow shallower gradually, as the animals within it prolong their operations upwards. But as the water

shoals, and the rain falls into it, it at length becomes freshened, so that the animals die, and the operation of filling it up ceases. Thus it becomes a fresh-water lake, and forms that receptacle which is so common a feature in all the flat islands of those seas.

Of whatever size the circle may be, but particularly if it be large, the islands begin first to collect on the outside of the reef, while within it, projecting parts, or banks and rocks, are scattered in different places. The ridge, or dam, to windward, under the protection of which the whole mass extends, is produced by the fragments of the corals. Whenever they have arrived at the surface of high-water mark, they cease to grow any longer, as the animal cannot live out of the water. But at low water, the reef is of course above the sea. Thus the force of the waves breaks off the upper parts, and washes them onwards to leeward, where they collect; while the animals, still working upwards on the windward side, keep up a constant supply of materials destined to the same end. Thus a bank of dead matter, or of fragments and sand, produced by the wear of the corals, is formed on the top of the living rock, and cemented by the solvent power of the water on the carbonate of lime. In this manner, it is raised above the level of the high-water mark, and kept smooth by the surf which continually breaks over it, until it is elevated even beyond the reach of the sea. The sand and fragments in time consolidate, so as to produce regular strata, resembling the calcareous rocks of Guadaloupe, Bermuda, Bahama, and other West India islands; and fragments of these, forming large blocks of stone, are frequently piled up in the ridge, and even further onwards, till a large extent of surface becomes thus consolidated by the aid of more sand and fragments, and sometimes by that of shells also, into a solid mass of land. As the same process is also going on in the interior parts, where the projecting banks lie, all these at length extend and unite; so that islands of any magnitude may in this manner at length be produced. Occasionally, the lakes before-mentioned, are also filled up by the growth and decomposition of vegetables, becoming first marshy spots, and at length dry land. Had it not become a sort of fashion in phi-

losophy to omit all consideration of final causes, I might here point out the singular and beautiful arrangement thus made for providing fresh water for the eventual inhabitants of islands, which, from their necessary want of springs, or other modes of supply, could never have become the residence of man; of the improvident being at least, whose lot it must be to commence the population of these new regions.

The remainder of the operation is to clothe these islands with soil and vegetation. This is the work of time, yet it is more rapid than would be expected. The first foundation of it is laid by the sand which the sea produces from the destruction of the corals, and by the sea plants which take root and grow upon it. Sea birds, finding a place to settle in, add something; and at length the seeds of various plants floating about the ocean are arrested and begin to grow, when a vegetable covering succeeds. Among these plants, the most conspicuous are the Scævola, Pandanus, Cerbera, Morinda, Hernandia, and others, which first begin to grow in the outer bank, where their seeds were originally arrested, and at length spread over the whole. Last of all comes Man, and the island forms a part of the inhabited world.

It is evident, that islands formed on this principle, can have no great elevation above the water; and accordingly, those which are entirely flat, are scarcely elevated more than five or six feet above the high-water mark. But as many of them are higher, it is necessary to resort to some new principle for effecting this purpose. This principle is that action of a subterraneous elevating force, which forms the main object of this communication; and by means of which the phenomena of the coral islands become connected with those of the Italian alluvia.

Tongataboo, already mentioned, is ten feet above the high-water mark; which is a greater elevation than can be produced by the action of the sea, supposing that the whole of that space consisted of fragments such as have been described, and not of perfect corals, which cannot raise themselves to the least distance above the sea. But Captain Cook observed in many islands, that the corals, with all their characters as perfect as

if they had been alive, were found at elevations of even an hundred feet above this. It is very certain, that the ocean could not have been depressed by that quantity, or rather that it never could have stood an hundred feet higher than it does at present; so that we must conclude that this island has been elevated. Though certain geological theorists should even choose to imagine this, there are still sufficient proofs here of the elevation of the submarine land. It is not difficult to trace the causes to which this is owing, which have effected in the bottom of the ocean, the changes necessary for the production of these results: and it will be seen, that they must have depended on the action of volcanic powers. We shall be at no loss in discovering the actual existence of this cause in many places, but the following islands will afford as convenient and satisfactory proofs of it as any other.

If we take the two islands of Tongataboo and Eeooa, we shall find that they form the first link in this chain, and one which is peculiarly valuable, from the proximity of these two tracts of coral land. Eeooa is separated from the former by a distance of only twenty miles. This island consists of a hill of considerable elevation, although its height is unfortunately not given in Cook's narrative. This omission, however, is not of any moment for the present purpose, as the essential circumstance is, that coral was observed on it at 300 feet above the level of the sea, continuing to near the summit. The soil above the coral is described as consisting of a soft yellow sandstone and a reddish clay. Now the position of the coral here is such as, even in a greater degree than in the preceding instances, to indicate the former existence of a force which must have raised it to that height above the level of the sea. From the proximity of these two islands, it is also probable that both of them were raised by the same force, and at the same time; and that the chief power was exerted under Eeooa, while the much lower island of Tongataboo was raised to so inconsiderable a height, comparatively, because it lay on the verge, or towards the evanescent margin of the expansive and elevating force. No other cause is adequate to the production of these effects

and it is evident that the action which produced the greatest, is also capable of accounting for the least, of these.

Now, although it may be said that no volcano exists in Eeooa, and that such a cause cannot therefore be admitted, it will be sufficient to shew that volcanoes have in other instances, and in this sea, exerted that very action, and in such a manner, that the coral rises upon the sides of the volcanic mountain; proving, in these cases, what may safely be inferred in the others, that it is not only capable of producing the required effects, but that, in these instances, it has actually produced them. That force, therefore, which has exerted its action, so as entirely to erupt the volcanic matter, may well be allowed to have also exerted that much less one, which was sufficient, as in the case of earthquakes, to alter the level of the submarine land.

It is possible that the volcanic action may here have been exerted under Eeooa itself, as the nature of the summit of the hill is not described by Cook. On other occasions he has neglected to notice volcanic rocks where we now know that they exist; and this is a subject which did not excite the attention of Mariner. But whether this be the case or not, the presence of a volcano in this group of islands is established. Toofooa contains one which is always burning, and this island is only seventy miles distant from Tongataboo. The small island Kao, about three miles from Toofooa, is also described as a cone, so that it is probably also of the same nature.

There is indeed reason to think that a volcanic force has been exerted very extensively in this part of the south Pacific Ocean. In Cook's arrangement, upwards of 150 islands are associated under the term Friendly Isles, and of these thirty-five are hilly. Otaheite, in the same sea, is of this form, and so are Bolobola and Eimeo. Though he has not mentioned volcanic rocks among these islands, it is now known that they occur in many places, and there are three burning volcanoes even in the Friendly Isles.

In further confirmation of this view, Eap, which lies to the westward of the Caroline Islands, is a seat of volcanic energy. Earthquakes are here frequent and violent, according to Kotzebue. He further remarks, that when Ulea trembles, all

the coral reefs in the vicinity are shaken. In the north Pacific also, coral is found in Owhyhee, inland and above the sea; and in this island, Mouna Roa, and probably all the rest of this lofty mountainous group, are formed of volcanic rocks.

These facts complete the chain of evidence in a manner that must satisfy every reasoning mind as to the causes which have raised, even the lowest of the elevated islands, above the level of the ocean. It is unnecessary to enlarge on a question so obvious. But the elevation of volcanic islands in other seas, mentioned at the commencement of this paper, serves to illustrate and confirm these reasonings. Those phenomena which have been detailed in the first division of this article, confirm also, as they receive illustration from that which has now been described. In the same way the changes in the level of the land adjoining to many well known terrestrial volcanoes, which have been accompanied by the tremendous phenomena of earthquakes, would also serve to establish the truth of this explanation, could any further confirmation of a conclusion so obvious be required.

In terminating these remarks on the coral islands, it will not be uninteresting to observe, that analogous appearances occur in the volcanic islands of the African coast. Secondary limestones are found lying upon those rocks, which are the produce of fire, containing marine remains, yet elevated above the surface of the ocean. If the elevation of these strata, abstractedly considered, should be thought to prove nothing more than what may be inferred from the analogous appearances that are to be seen all over the world, it must be recollected, that there is here present, not only an obvious and active cause, sufficient to raise them from the bottom of the sea, but that the actual agency of that power in analogous cases, is proved by the phenomena of the islands now described. As far as it is a question of relative antiquity alone, there may be differences in the results, or in the present appearances; but the strength of the general argument derived from them remains undiminished.

As it is not here my object to extend these inferences to the general derangements and elevations of the strata of the globe, I shall leave the preceding facts to make that impression which

geologists may permit, according to their several views or prejudices. But there remains a chemical question respecting the generation of coral islands, which is extremely obscure, but which is also highly interesting, not only as it relates to the production or collection of these enormous masses of calcareous earth, but as it bears on the formation of the ordinary stratified limestones.

There is, in the first place, neither proof nor probability that lime is the produce of animal action, as has been supposed by some persons. The recent discoveries respecting the nature of the earths, must, indeed, have set this question at rest. Whatever difficulties may be found in the supposition, it is probable that it is, in these cases, procured from the decomposition of the calcareous salts of the ocean; and, however, we may choose to foresee a period when that supply must cease, we must be content for the present to rest in the belief that this is its real origin, without inquiring further what, or whether any, provision is made for its perpetual renewal.

But it is sufficient for the present object, to point out the enormous masses of calcareous matter thus produced, as we are, in this case, very sure that it is, by the mere operations of animals. If the bulks of Tongataboo, and of the great coral reef of New Holland, be estimated by their extent and depth, as already stated, it will be seen that they are equivalent to some of the largest deposits of secondary limestone with which we are acquainted. The latter will bear a comparison even with the great ridges of the Jura, or the Apennines. That supposition of some geologists, that the secondary limestones have been produced by the animals whose shells are still imbedded in them, is far therefore from being so absurd as it has sometimes been considered. It is certainly not necessary to imagine that all limestones have originated in the same sources; but when we recollect that these rocks abound among the secondary strata, while they are comparatively rare among the primary, diminishing in quantity in proportion as we recede from those periods in which the earth was inhabited, we contemplate a fact which cannot be looked on with indifference.

Art. IV. *On the Morbid Influence of the Spinal Nerves; in a Letter from* R. P. Player, Esq., *to the Editor.*

Sir,

At the commencement of the present year you favoured me with publishing in the *Journal of Science*, an account of a morbid connexion which exists between the origins of the spinal nerves, and diseases of parts to which they are distributed. I now beg leave to submit to your notice some results of further attention to this subject.

1. In almost every disease of the upper and lower extremities, of the neck, and of the trunk and its organs and viscera; preternatural tenderness may commonly be discovered on pressure between the vertebræ from which the nerves emerge which proceed to the affected parts, or those spinal branches which are more immediately connected therewith.

2. In diseases in which the circulation is much accelerated, in cases of disease affecting important organs, and more particularly when occurring in old age, this symptom may frequently be discovered to extend along a considerable portion of the vertebral column.

3. Diseases of the head, and its organs, and of those to which the par vagum is distributed, appear primarily to be connected with, if not consequential on, this morbid state, of one or more parts of the spine. The effects of remedies directed to the spine, seem to prove this. When organization is impaired, effects then become causes.

4. In many diseases besides the existence of preternatural tenderness about the origins of the nerves which proceed to the affected parts, this symptom may also be discovered about the origins of one or more of the intercostal nerves on the left side of the spine beneath the scapula, and opposite the upper portion of the stomach.

5. In diseases of females this symptom may, in like manner, be frequently found about the origins of some of the sacral nerves.

6. By the employment of remedies at these parts, some of our most obstinate diseases may be rendered comparatively tractable. For instance, *pain*, in general, may be almost immediately relieved; and the symptoms of gout, rheumatism, phthisis, and cancer, more effectually controlled than by any other means I am acquainted with.

7. The principal remedy is the abstraction of blood in a quantity proportionate to the vascular fulness of the patient. General bleeding being premised, when requisite.

8. Cupping is generally the best mode of removing vascular fulness from the origins of the spinal nerves; this must be repeated according to the recurrence of symptoms or the chronic nature of the case. The glasses should be much larger than they are usually made. Blisters, and similar remedies, become proper, after the due depletion of blood.

9. A recent fit of the gout may be cured by a single abstraction of blood proportionate to the plethoric state of the patient; but in this disease the origins of the intercostal nerves opposite the stomach will commonly require to be relieved, as well as the origins of those which proceed immediately to the affected part or parts.

10. With this precaution, not only the phænomena of gout, but their cause also, appears to be removed; and if organization has not been impaired, the constitution to be completely relieved.

11. In cases of gouty affection of the stomach itself, the abstraction of blood from, or a blister applied over, the origins of the affected intercostal nerves, as the case may require, gives speedy and complete relief.

12. The preceding diseases are only adduced as examples of the advantage of directing remedies *to the spinal brain, and to the origins of the nerves which proceed to affected parts,* and to excite attention to the extensively beneficial application of which this practice appears capable in the relief and cure of *diseases in general;* but it is by no means intended to recommend it to the exclusion of other remedies.

13. Works on Pathology and Physiology, furnish numerous

cases and experiments which tend to prove that *pain* and *disorganization*, as well as *impaired function* and *paralysis*, are consequent on causes which interrupt the due transmission of nervous influence to the affected parts. It has been very justly remarked that nature is sparing of causes, but profuse of effects.

I am, Sir,

Your very obedient Servant,

Malmsbury, R. P. PLAYER.

Dec. 4, 1822.

ART. V. LAMARCK's *Genera of Shells*.

(Continued from page 86.)

2. Mactra *.

Shell transverse, inequilateral, subtriangular, rather gaping at the sides; beaks prominent. One compressed grooved cardinal tooth, on each valve, and, near it, a pit, extending inwards. Two compressed, entering †, lateral teeth, near the hinge. Ligament internal, inserted in the cardinal pit. If the pit be very large, the cardinal tooth is very oblique, short, and even partly obliterated, but the lateral teeth always exist.

Type. *Mactra gigantea* ‡.

Shell, large, solid, whitish-yellow, transversely substriated; gaping within the nates; cardinal pit, very large, cordate. 33 species. *South American Seas.* Pl. v. Fig. 32.

3. Crassatella §.

Shell inequilateral, suborbicular or transverse; valves close. Two subdiverging cardinal teeth, with a pit by the side of them. Ligament internal, inserted in the pit of each valve. Lateral teeth, none, or obsolete.

The crassatella is distinguished from the mactra and lutraria by the valves, when shut, being quite close on both sides. In

* *Mactra, a kneading trough.*

† *Intrantes*, when the hinge teeth of the opposite valves take into each other, like the cogs of a couple of wheels, they are called *intrantes*, entering.

‡ *Gigantic.* § From *crassus, thick.*

a few species the ligament appears a little, on the outside. They are all sea shells, and generally become very thick by age.

Type. *Crassatella kingicola* *.

Shell ovate, orbicular, subgibbous, whitish, inclining to yellow, obsoletely radiated; transverse striæ delicate; nates plicate. *New Holland.* 18 Species. Pl. v. Fig. 33.

4. Erycina.

Shell transverse, subinequilateral, equivalve, seldom gaping. Two unequal, diverging, cardinal teeth, with an interposed pit. Two oblong, compressed, short, entering, lateral teeth. Ligament internal, fixed in the pits.

One of the cardinal teeth joining the base of the lateral tooth on the same side, has been sometimes mistaken for a bifid tooth, and its external lobe has been supposed to exhibit the element of the plicated tooth of the mactræ; but the corresponding hollow on the opposite valve shows that idea to be erroneous.

One species. *Erycina cardioides* †.

Shell ovate orbicular, small, decussately striated; transverse striæ remote: the longitudinal very close. *New Holland.* Pl. v. Fig. 34.

5. Ungulina ‡.

Shell longitudinal, or transverse, rounded on the upper part, nearly equilateral; valves close; beaks eroded. One short, subbifid, cardinal tooth on each valve, with an oblong marginal pit beside it, divided in two by a contraction in the middle. Ligament internal, inserted in the pits.

The ungulinæ are furrowed externally, and tinged red on the inside.

* *An inhabitant of King Island,* New Holland. Our figure is copied by Mr. G. B. Sowerby's permission, from his elegant and accurate work, now in course of publication, entitled 'The Genera of Recent and Fossil Shells.' We have not been able to procure a specimen of the species.

† *Cardium-shaped* Erycina. We have given a second figure, E. *complanata* of Sowerby.

‡ *Ungula*, a *nail*, or *hoof*.

Type. *Ungulina transversa* *.

Shell transverse-rotundate, rugose, of a yellow-brown colour; its width rather exceeds its length.

2 Species. Locality unknown. Pl. v. Fig. 35.

6. Solenomya †.

Shell inequilateral, equivalve, transversely elongated, obtuse at the extremities; epidermis brown, shining, extending over the edges. Beaks not projecting, indistinct. One dilated, flattened, very oblique, cardinal tooth on each valve, slightly concave above, to receive the ligament. Ligament partly internal, partly external.

The Solenomyæ resemble the modiolæ, at first sight, but are allied, by their characters, to the solenes, and still more to the anatinæ. They are thin shells, almost cylindrical, with diverging rays from the beaks to the upper border and lateral extremities of the valves.

Type. *Solenomya Mediterranea* ‡.

Shell oblong, brown, smooth, radiated with yellow; valves near the nates undivided. 2 Species. *New Holland*. Pl. v. Fig. 36.

7. Amphidesma §.

Shell transverse, inequilateral, suboval or rounded, sometimes slightly gaping at the sides. Hinge with one or two teeth, and a narrow pit, to receive the interior ligament. Ligament double; one external, short, the other internal, and fixed in the cardinal pits. In some instances there are, besides the hinge teeth, more or less prominent lateral teeth. These shells are generally small.

* *Transverse*. We have given the second species of Lamarck, instead of the *U. oblonga*, which is his type—not having been able to procure that shell in time for the engraver.

† As being allied to the *myæ* and *solenenes*. We have taken the liberty, at the suggestion of a learned friend, to alter Lamarck's name to the more expressive one, as above.

‡ *Mediterranean*. The second species of Lamarck, whose type is *S. australis*, a shell we have not been able to procure.

§ From αμφι, *circum*, and Δεσμος, *ligamen*, denoting its having a ligament on both sides; *i. e.* an internal, and an external.

Type. *Amphidesma variegata* *.

Shell suborbicular, flattened convex, thin, whitish, inclining to purple, with red spots; nates contiguous, radiated. 16 Species. *African Coast?* Pl. v. Fig. 37.

2d Family.

CORBULEA. (2 genera.)

Shell inequivalve, ligament internal.

Inequality of the valves is not peculiar to irregular shells; regular shells, the individuals of a species of which are perfectly alike, are often inequivalve, as the cardia, and others, and also those of the present family, which are regular, inequivalve, inequilateral, and transverse. They are sea shells, and generally small, or of moderate size, not sensibly gaping, and one of the beaks is always more prominent than the other.

1. Corbula †.

Shell regular, inequivalve, inequilateral; not at all, or very slightly, gaping. One conical, curved, ascending tooth on each valve, and, beside it, a pit. No lateral teeth. Ligament internal, fixed in the pits.

The corbulæ are distinguished from the ungulinæ and crassatellæ, by the inequality of their valves, and by the strong, prominent cardinal tooth, which characterizes them.

Type. *Corbula nucleus* ‡. (Mya inequivalvis. *Montag.*)

Shell globoso-triangular, transversely striated, somewhat wrinkled; one of the nates more gibbous than the other. *New Holland.* 13 Species. Pl. v. Fig. 38.

2. Pandora §.

Shell regular, inequivalve, inequilateral, transversely oblong; upper valve flattened, lower convex. Two oblong, diverging, unequal cardinal teeth in the upper valve; two oblong pits in the lower. Ligament internal.

The pandoræ are distinguished from the placunæ, by having

* *Variegated.* † *A little basket.*

‡ *A kernel.* Lamarck's sixth species—his type is *C. australis.*

§ From παν and δωρον, *every gift.* A personage of fabulous history, on whom all the heathen gods bestowed a gift.

two muscular impressions, and from the chamacea, by the shell being regular and free.

Type. *Pandora rostrata* *. (Tellina inequivalvis. *Linn.*) Anterior side of the shell longest; attenuated, beaked, and angular, in that part, in both valves. *Mediterranean.* 2 Species. Pl. v. Fig. 39.

3d Family.

LITHOPHAGA. (contains 3 genera.)

Boring shells, without any accessary pieces, or sheath, and more or less gaping at the anterior side. Ligament of the valves external.

The animals of these shells pierce calcareous rocks, in which they live. The particulars of their organization are unknown. The posterior side of the shell is short, rounded, or obtuse; the ligament of the valves, always external. Fleuriau de Bellevue thinks that the boring shells do not pierce stones mechanically, but by means of a solvent liquid, secreted by the animal †.

1. Saxicava ‡.

Shell bivalve, transverse, inequilateral, gaping anteriorly at the upper margin. Hinge almost without teeth. Ligament external; sometimes the hinge has two distant, scarcely dentiform tuberosities. The shells are short and obtuse posteriorly, anteriorly longer, flatter, and often truncated. They are small, or of moderate size.

Type. *Saxicava rugosa* §. (Mytilus rugosus. *Linn.*) Shell rough, ovate, obtuse at both ends, transversely striated. *North Sea.* 4 Species. Pl. v. Fig. 40.

2. Petricola ||.

Shell bivalve, subtriangular, transverse, inequilateral; posterior side rounded; anterior attenuated, slightly gaping. Hinge with two teeth on each valve, or only on one.

* *Beaked.* † A very improbable supposition.
‡ From *saxum*, a stone; and *cavo*, to hollow. § *Wrinkled.*
|| From *petra*, a rock, and *colo*, to inhabit.

Type. *Petricola striata* *.

Shell ovate triangular, striated with close-set longitudinal furrows; transverse striæ fewer; anterior side compressed, *Mediterranean.* 13 Species. Pl. v. Fig. 41.

3. Venerupis †.

Shell transverse, inequilateral, posterior side very short, anterior slightly gaping. Two cardinal teeth on the right valve, three on the left, sometimes three on each; teeth small, approximate, parallel, and scarcely or not at all diverging. Ligament external.

The hinge of the venerupes appears analogous to that of the veneres, but they are distinguished from them by the cardinal teeth, which are somewhat differently disposed. They are perforating shells, and differ from the petricolæ, by having three cardinal teeth, at least on one valve.

Type. *Venerupis perforans* ‡. (Venus perforans. *Montag.*)

Shell ovate, rhomboidal, transversely striated; anterior side longest, lamellar, subtruncated. *English Coast.* 7 Species. Pl. v. Fig. 42.

4th Family.

NYMPHACEA. (10 genera.)

Two cardinal teeth, at most, on the same valve. Shell often slightly gaping at the lateral extremities. Ligament external. Nymphæ § generally projecting externally.

This family is subdivided, into N. solenaria, and N. tellinaria. The first subdivision contains three genera, the second seven.

Of the nymphacea, some were referred to the solenes, and some to the tellinæ, to neither of which, any of them, properly belong. The animal of these shells has a small, often compressed foot, neither similar to, nor disposed like, that of the

* *Striated*—Lamarck's fifth species. His type is *P. lamellosa.*

† From *Venus*, and *rupes*, a rock. The Venus of the rocks.

‡ *Perforating.*

§ *Nymphæ*—Impressions, remains, or indications of the situation of the nerve, or ligament, particularly visible in some of the veneres. They are situated under the beaks, or summits, before or in the centre of the *corselet*, i. e., the part which contains the ligament.—*De Montfort*, vol. I, lxxii.

solenaca or myaria. The shells gape but very little, if at all, at the lateral extremities; the cardinal teeth are seldom diverging, and we never find three on the same valve. They are shore shells.

N. Solenaria. (3 genera.)

1. Sanguinolaria *.

Shell transverse, subelliptical, slightly gaping at the lateral extremities; superior margin arched, not parallel to the lower; two approximate cardinal teeth on each valve.

The sanguinolariæ are distinguished from the solenes by the superior margin not being parallel to the inferior; they also gape but little at the lateral extremities.

Type. *Sanguinolaria rosea* †. (Solen sanguinolentus. *Gmel.*) Shell semi-orbicular, slightly convex, white; nates rose-colour, transverse striæ arched. 4 Species. *Jamaica.* Pl. v. Fig. 43.

2. Psammobia ‡.

Shell transverse, elliptical or oblong oval, rather flat, slightly gaping at both sides; beaks prominent. Two cardinal teeth on the left valve, and only one entering tooth on the opposite valve.

The form of the Psammobiæ approaches nearer to that of the tellinæ, than of the solenes; but, besides gaping at the sides, they have not the irregular fold, on the anterior side, of the former, although they frequently have an angle or fold, of the same form, on the anterior side of both valves.

Type. *Psammobia feroensis* §. (Tellina feroensis. *Gmel.*) Shell oblong-ovate, delicately striated transversely; white, painted with rosy rays; area of the anterior angle decussately striated. *North Seas.* 18 Species. Pl. v. Fig. 44.

3 Psammotea ||.

Shell transverse, oval, or oblong oval, slightly gaping at

* From *sanguis*, blood.

† *Rosy*—Lamarck's second species. His type is *S. occidens.*

‡ From ψαμμος, sand, and βιος, life.

§ Of *Ferroe.* Lamarck's second species. His type is *P. virgata.*

|| From ψαμμωδος, *arenosus*, sandy.

the sides ; only one cardinal tooth on each valve, sometimes only on one valve.

The psammotææ are merely degenerated psammobiæ, differing from them in having only one cardinal tooth on the left valve ; or sometimes one valve has no teeth, and the other two. They have not the form of the solenes, and their beaks are prominent. The ligament is external, attached to slightly projecting nymphæ, and the anterior side is destitute of the irregular fold of the tellinæ

Type. *Psammotæa donacina* *.

Shell ovate, sub-depressed ; whitish, with remote red rays ; transverse striæ small, very elegant. *European Ocean?* 8 Species. Pl. v. Fig. 45.

N. Tellinaria. (7 Genera.)

The nymphacea tellinaria are very slightly, or not at all gaping at the lateral extremities, and scarcely ever have more than two cardinal teeth on the same valve. The ligament of the valves is external, but sometimes more or less buried, and, if the borders of the *scutcheon* † be very near together, it appears internal. The shells inhabit the sands, near the coasts. The following five genera have, besides the sometimes almost effaced cardinal teeth, one or two lateral teeth ; the sixth and seventh (capsæ and crassinæ) have none.

1. Tellina ‡.

Shell transverse or orbicular, in general flattened ; anterior side angular, with a flexuous and irregular fold on the margin. One or two cardinal teeth on the same valve. Two lateral teeth, often distant.

The tellinæ are readily known by the flexuous fold near the short side, on their superior margin ; almost all of them have also lateral teeth ; which are flattened on one valve. They are marine shore shells, slightly, or not at all gaping at the sides,

* *Allied to the donax.* Lamarck's 8th species. His type is *P. violacea.*

† *Ecusson*, the central part of the corselet.

‡ *Tellina*, the original latin name.

often smooth, sometimes squamose, and in general adorned with lively colours.

With the tellinæ, as well as the donaces and capsæ, the ligament of the valves is situated on the shorter side of the shell, and is wholly external. The valves of the same shell, though equal in their contour, are not perfectly similar; sometimes one is more protuberant than the other, sometimes the striæ of one valve, or of one of its sides, are not like those on the other. In some species the hinge resembles that of the capsæ, but the fold on the margin distinguishes them.

Type. *Tellina radiata**. (Idem. *Linn.*)

Shell oblong, longitudinally very finely striated, delicate; white, with red rays. *European and American Ocean.* 54 Genera. Pl. v. Fig. 46.

2. Tellinides†.

Shell transverse, inequilateral, rather flattened, slightly gaping at the sides, beaks small, somewhat depressed; no irregular fold on the margin. Two diverging cardinal teeth on each valve; two lateral teeth, almost obsolete, on one valve, the posterior one near the cardinal teeth.

The tellinides differs from the psammobia, by having lateral teeth; from the tellina, by wanting the flexuous marginal fold, and from the lucina by its gaping, and not having the internal fascial impressions.

One Species. *Tellinides Timorensis.*

Shell oval-elliptical, flattened, white, rather thin, transversely striated, striæ concentric; a depression on the anterior side of each valve; superior margin wavy. *Indian Ocean.* Pl. v. Fig. 46‡.

3. Corbis§.

Shell transverse, equivalve, no irregular fold on the anterior margin; beaks curved inward, opposite to each other. Two

* *Radiated.*

† From *tellina*, and εἶδος, form, denoting its resemblance to the preceding genus.

‡ Copied from Bowdich's figure.—*Elements of Conchology.*

§ *A basket.*

cardinal teeth; two lateral teeth, the posterior nearest the hinge. Muscular impressions simple.

The corbis is principally distinguished from the lucina by the animal which inhabits the shell, also by not having one of the muscular impressions lengthened into a band; and from the Tellina, by wanting the irregular fold on the anterior margin.

Type. *Corbis fimbriata**. (Venus fimbriata. *Linn.*)
Shell transversely oval, gibbous, longitudinally striated; transverse furrows wavy; margin indented. *Indian Ocean.* 3 Species. Pl. v. Fig. 47.

4. *Lucina.*

Shell suborbicular, inequilateral; beaks small, pointed, oblique. Two diverging cardinal teeth (one bifid,) which vary or disappear with age. Most species have two lateral teeth, the posterior nearest the cardinal; some have no lateral teeth. Two very separate muscular impressions, the posterior produced in the form of a band, sometimes very long, and extending to the middle of the valve. Ligament always external, and apparent.

Type. *Lucina Jamaicensis* †. (Venus Jamaicensis. *Chemn.*)
Shell lentiform, rough, lamellar-sulcate; internally rather clay-coloured; lamellæ short, concentric; anterior side of both valves angular. *Antilles.* 20 Species. Pl. v. Fig. 48.

5. Donax ‡.

Shell transverse, equivalve, inequilateral; anterior side very short and obtuse, and, as it were, truncated.

Two cardinal teeth, either on both valves, or only on one: one or two lateral teeth, more or less distant. Ligament short, external, inserted in the place occupied by the lunula.

This genus is characterized by its rather flattened and almost triangular shell, and by having, at the hinge, beside the cardinal teeth, one or two rather distant lateral teeth, separated from the cardinal teeth, and analogous to the lateral teeth of the

* *Fringed, or scalloped.* † *Of Jamaica.*

‡ Δοναξ, a *reed*, or *arrow*. Donax is used by Pliny as the name of a sea-fish.—32. 11.

mactræ, lucinæ, tellinæ, corbes, and cyclades. The ligament of the donaces and the tellinæ, is always on the shortest side of the shell, but in the veneres and cythereæ it is on the longest. The donax has not the flexuous fold of the tellina.

The donaces are marine shore shells, smooth, or finely striated, and often decorated with lively and agreeable colours.

Type. *Donax scortum* *. (Idem. *Linn.*)

Shell triangular, anteriorly acute; decussately striated; corselet cordate, flat; margins nearly smooth. *Indian Ocean.* 27 Species. Pl. v. Fig. 49.

6. Capsa†.

Shell transverse, equivalve, close. Hinge with two teeth on the right valve; only one bifid, entering tooth on the other. No lateral teeth. Ligament external.

The capsæ are rather inequilateral shells, with the ligament on the short side, like the tellinæ and donaces. They are allied to the psammobiæ, and certain tellinæ, by their cardinal teeth, but they scarcely gape at all at the sides, and have not the flexuous fold of the tellinæ.

Type. *Capsa lævigata* ‡. (Donax lævigata. *Gmelin.*)

Shell triangular, subequilateral, obsoletely striated; epidermis greenish yellow; internally, and at the nates, violet coloured. *Tranquebar.* 2 Species. Pl. v. Fig. 50.

7. Crassina §.

Shell suborbicular, transverse, equivalve, subinequilateral, close. Two strong diverging cardinal teeth on the right valve, and two very unequal teeth on the other. Ligament on the longest side, external.

The crassina resembles a small crassatella, both in appearance, and in the thickness, solidity, and perfect closeness of the valves when shut, but it differs from them by the position of the ligament. It is distinguished from the venus by having only two teeth on each valve, those on the left even appearing

* The *skin of a beast*; also a *harlot*. † A *coffer*, or *box*.
‡ *Smoothed*. § From *crassus*, thick.

almost like a single tooth, one of them being very large, and the other but very slightly prominent.

One Species. *Crassina Danmoniensis* *. (Venus Danmoniensis. *Montague.*)

Shell orbiculo-triangular, brownish yellow, transversely wrinkled; wrinkles parallelly striated, scalariform †; internally white. *British Ocean.* Pl. vi. Fig. 51.

5th Family.

CONCHÆ ‡. (7 Genera.)

Three cardinal teeth at least on one valve; as many, or fewer, on the other. Sometimes lateral teeth.

The conchæ constitute one of the most numerous and beautiful families of the conchifera. Their shells are equivalve, orbicular, or transverse, always regular, free, and in general very close, especially at the sides. They are more or less inequilateral, and seldom have true radiating ribs externally.

The animal of the conchæ often projects beyond the shell two tubes, or siphons, formed by the mantle, one to convey water to the branchiæ and mouth, the other for its excretions. Its foot is remarkably lamellar.

This family is subdivided into fresh water conchæ and marine conchæ: the first subdivision contains three genera, the second four.

C. FLUVIATILES §. (3 Genera.)

Shells covered with a false epidermis, and having two lateral teeth near the hinge.

Like the naiada these shells are covered with a kind of greenish epidermis, which turns more or less brown, and is often eroded at the beaks. The fresh-water conchæ inhabit lakes and rivers, keeping generally in the mud, with their beaks downwards, and buried in it. They are distinguished from the naiada by the projecting siphons of the animal, and by the hinge of the shell, which has cardinal teeth like those of the

* *Devonshire.*

† *Scalariformibus*, arranged one above another, like a flight of steps.

‡ Strictly *bivalve shells.*

§ *Belonging to rivers*

veneres, whilst nothing similar is seen in the animal or shell of the naiada. The fresh water conchæ differ from the marine, not only by their localities, but by their having lateral teeth near the hinge, which are never found in the latter.

1. Cyclas*.

Shell ovate-globular, transverse, equivalve, beaks prominent. Cardinal teeth very small, sometimes scarcely any ; occasionally two on each valve, one of them folded into a double tooth; sometimes only one folded, or lobed tooth on one valve, and two on the other. Lateral teeth transversely elongated, compressed, lamellar. Ligament external.

The cyclades are small shells, with thin valves, and never have three teeth on either. The beaks are never eroded. Some are so thin as to be transparent, and very brittle. They are grayish green, or slightly yellowish ; some smooth, others transversely striated, with sometimes light-coloured bands.

Type. *Cyclas rivicola*†. (Cyclas cornea ‡. *Draparn.)*

Shell subglobular, rather solid, elegantly striated, horn-green colour; internally bluish; two or three slightly coloured transverse furrows. *Rivers of Europe.* 11 Species. Pl. vi. Fig. 52.

2. Cyrena.

Shell rounded-triangular, turgid or ventricose, solid, inequilateral, covered with an epidermis, beaks eroded. Three cardinal teeth on each valve ; almost always two lateral teeth, one of them often situated near the cardinal. Ligament external, on the largest side.

The cyrenæ are generally thick, and rather large shells, always covered with a greenish or brown epidermis. They are distinguished from the cyclades by having three cardinal teeth on each valve. They have also lateral teeth, one of which is often placed below the corselet. They inhabit rivers, and appear to be foreign to Europe.

* Κυκλας, orbicular, having a rounded form.

† *Inhabiting rivers.*

‡ *The cyclas cornea (horny)* of Lamarck (his second species) is the *tellina cornea* of Linnæus.

Lamarck divides the species into (1) Those with serrated lateral teeth, and (2) Those whose lateral teeth are entire.

Type. *Cyrena cor**.

Shell elongated-cordate, inequilateral, tumid, scalariform-sulcate; nates prominent, involute.

Brought by Olivier. 7 Species of the first division, 4 of the second. Pl. vi. Fig. 53.

3. Galathea.

Shell equivalve, subtriangular, covered with a greenish epidermis. Cardinal teeth furrowed; two on the right valve, approaching at their base with an uneven cavity in front, three on the other valve disposed in a triangle, the middle one advanced, separate, large and callous. Lateral teeth distant. Ligament external, short, projecting, turgid. Nymphæ prominent.

The galathea is distinguished from the cyrena by the peculiar form of its cardinal teeth. The muscular impressions are lateral, and appear double on each side.

One Species. *Galathea radiata*†. (A variety of this genus is the *venus subviridis, of Gmelin.*)

Rivers of Ceylon. A rare shell, milk-white under the epidermis, with violet-coloured spots near its base, and two to four violet rays. Pl. vi. Fig. 54.

C. Marinæ‡. (4 Genera.)

Generally no lateral teeth; rarely, the whole shell, except the beaks, covered with the *drap marin.* The marine conchæ are extremely numerous, varied, and often elegant. Linnæus classed them all under the genus Venus.

1. Cyprina§.

Shell equivalve, inequilateral, obliquely cordate, beaks obliquely curved. Three unequal cardinal teeth, approaching at

* *Heart.* Lamarck's third species; his type is *C. trigonella.*

† *Radiated.* ‡ *Marine.*

§ *Cyprian.* The island of Cyprus was consecrated to Venus.

their base, slightly diverging above. One lateral tooth, distant from the hinge, on the anterior side, sometimes obsolete. Calli of the nymphæ large, arched, terminated near the beaks by a pit. Ligament external, partly sunk under the beaks.

The cyprinæ are in general rather large shells, very like the veneres, and chiefly distinguished from them by having a compressed lateral tooth on the anterior side; by their large nymphæ, generally terminated by an oval pit, sometimes singularly large near the beaks; by the ligament extending under the beaks, and there filling up the terminal pit of the nymphæ, and by having an epidermis, or *drap marin*, almost like the cyrenæ. In the latter respect, and from their sometimes almost obsolete lateral tooth, the cyprinæ are somewhat allied to the fresh-water conchæ. Probably many of them inhabit the sea at the mouths of rivers.

Type. *Cyprina Islandica**. (Venus Islandica. *Linn.*)
Shell cordate, transversely striated, covered with an epidermis; anterior side subangular: no anus. *North Sea*, at the mouths of rivers. 8 Species. Pl. vi. Fig. 55.

2. Cythereа†.

Shell equivalve, inequilateral, suborbicular, triangular, or transverse. Four cardinal teeth on the right valve, three of them diverging, approximate at their base, and one, perfectly insulated, situated under the lunula. Three diverging cardinal teeth on the other valve, with a rather distant oval pit, parallel to the margin. No lateral teeth.

The cythereæ are distinguished from the veneres by having four cardinal teeth on one valve, and three teeth and the pit on the other. They are all sea shells, solid, in general variously and beautifully coloured, free, with the beaks curved, and moderately prominent. The oval insulated pit on the left valve corresponds to the insulated tooth on the right, having a

* *Of Iceland.* Lamarck's second species, his type, *Cyprina gigas*, being a fossil shell.

† *Cytherean*, a title of Venus, from the island *Cythera*, which was consecrated to her.

different direction from the cavities which receive the three cardinal teeth. Two of the cardinal teeth are often approximate; the third more diverging, being placed on the anterior side, under the nymphæ.

The species are subdivided into, (1) Shells, with the margin entire, and (a) the anterior cardinal tooth having a striated canal, or indented border—12 species; or (b) the canal not striated, nor border indented—50 species; (2) Shells, with the internal margin of the valves crenate, or indented: 16 species.

Type. *Cytherea lusoria**. (Venus lusoria. *Chemn.*)

Shell ovato-cordate, smooth, white; chestnut brown zones, interrupted in the middle; anterior cardinal tooth, with a striated canal. *China Seas.* In all 78 recent species, and 9 fossil. Pl. vi. Fig. 56.

3. Venus.

Shell equivalve, inequilateral, transverse, or suborbicular. Three approximate cardinal teeth on each valve; the lateral teeth diverging at the summit. Ligament external, covering the scutcheon.

The veneres are amongst the most beautiful of the conchifera. They are not distinguished by their general form from the cythereæ, wherefore, to ascertain their genus, we must examine the hinge; they are, however, more commonly transverse than orbicular. They are all sea-shells, free and regular. The middle cardinal tooth, which is often bifid, is straight, whilst the lateral are oblique and diverging; a few species have, nevertheless, all the cardinal teeth almost straight.

The animal of the venus appears to have the mantle open in front, allowing a passage to two siphons, more or less projecting externally, Its foot is compressed, and lamellar, variable in size and form.

The veneres live in the sand, at a small distance from the shore. They are found in all the seas, but are most numerous and varied in those of hot climates.

* As being used in *play*, for which purpose the Chinese and people of Japan employ this shell. They paint the inside of various colours.

The species are subdivided into, (1) Shells, with the internal margin of the valves crenate, or indented, and (a) having lamellar striæ—13 species; or (b) without lamellar striæ—14 species. (2) Shells with the internal margin of the valves entire—61 species.

Type. *Venus puerpera**. (Idem. *Linn.*)

Shell rotundo-cordate, gibbous, subglobular, whitish or ferruginous; longitudinal striæ close together; the transverse, membranaceous, and somewhat distant; anus cordate; corselet concealed by the lips on the upper part. *Indian Ocean.* In all 88 recent species, and 6 fossil. Pl. vi. Fig. 57.

4. Venericardia†.

Shell equivalve, inequilateral, suborbicular; generally with radiating, longitudinal ribs. Two oblique cardinal teeth, similarly inclined.

The venericardiæ seem to connect the conchæ with the cardiacea; their radiating ribs give them perfectly the appearance of cardia, and they are allied to the conchæ by their hinge, which would resemble that of the veneres, if it had a third diverging tooth on each valve. They appear, however, to differ from the carditæ, merely by wanting the lunular tooth, their two oblique teeth representing the lateral tooth of the carditæ, which is always channelled. Moreover, the lunula of these shells is always hollow, like those of the carditæ, and more or less apparent. They are chiefly fossil.

Type. *Venericardia planicosta*‡.

Shell obliquely cordate, very thick; ribs flat, entire, posterior and anterior obliquely furrowed. Fossil. *France, England, and Italy*, 11 Species. Pl. vi. Fig. 58.

6th Family.

CARDIACEA, (5 genera.)

Cardinal teeth irregular, either in form or situation, and generally accompanied by one or two lateral teeth.

* *Child-bearing.* † *Venus and Cardium*, as allied to both.

‡ *Flat-ribbed.* Lamarck's third species, the *V. imbricata*, is the *Venus imbricata* of Gmelin.

Most of the cardiacea are ventricose shells; almost all are furnished with radiating longitudinal ribs, and when viewed at the fore part, are heart-shaped. They are equivalve, regular, and sometimes gaping.

1. Cardium *.

Shell equivalve, subcordate; beaks prominent; valves indented, or plicate on the internal margin. Hinge with four teeth on each valve, namely, two cardinal, approximate and oblique, articulating crosswise with the corresponding teeth of the other valve; and two lateral teeth, distant, entering.

The prominent cordate beaks of the shells of this genus, first established by Linnæus, are very remarkable. The convex side of the valves is generally furnished with longitudinal ribs, more or less prominent, frequently striated, imbricate, or spinous; but their interior is smooth, and only furrowed towards the margin. The ligament is external, and very short; there are two faint muscular impressions.

The animal projects two unequal tubes from one side of the shell, in general shorter than those of the conchæ, and tellinaria, and fringed at their orifice; from the other side a large muscular falciform foot. It is said that some species spin a sort of byssus when they wish to fix themselves to marine substances.

The cardia generally live buried in the sands near the coasts. They are found in all seas, and some of the European fossil species are now only known in the recent state in the Asiatic ocean.

The species are subdivided into (1) shells which have no particular angle on the beaks, and whose anterior margin, is, at least, as large as the posterior,—38 species. (2) Shells whose beaks are carinate, or furnished with an angle, and whose posterior margin is often larger than the anterior. 10 species.

Type. *Cardium costatum* †. (Idem. *Linn.*)

Shell ventricose, subglobular, subequivalve; ribs prominent, carinate, concave; anterior side gaping.

African seas. In all 48 recent species, and 14 fossil. Pl. vi. Fig. 59.

* From καρδια, *cor*, a heart. † *Ribbed.*

2. Cardita*.

Shell free, regular, equivalve, inequilateral. Two unequal cardinal teeth ; one short, straight, situated under the beaks ; the other oblique, marginal, and extending under the corselet.

The carditæ may easily be confounded with the venericardiæ, if sufficient attention be not paid to the direction of the two teeth, which, in the latter, are, both of them, oblique and turned to the same side, which is not the case with the carditæ. Linnæus confounded these shells with the chamæ, from which they differ, in not being inequivalve, or irregular, nor ever fixed by the lower valve to marine substances. They are all sea shells, and from the great length of the anterior, and shortness of the posterior side generally appear to be longitudinal. Some species are said to fix themselves to marine substances by a sort of byssus, like the arcæ and mytili.

The species are subdivided into (1) Those whose shell is subcordate, or oval, and rather transverse than longitudinal.—11 species. (2) Shell rather longitudinal than transverse.—14 species.

Type. *Cardita sulcata*†. (Chama antiquata. *Linn.*)
Shell subcordate, tessellated with white, red and brown ; ribs longitudinal, convex, transversely striated.

Mediterranean. In all 25 species. Pl. vi. Fig. 60.

3. Cypricardia.

Shell free, equivalve, inequilateral, obliquely or transversely elongated. Three cardinal teeth under the beaks, and a lateral tooth extending under the corselet.

The cypricardiæ differ from the carditæ, which they resemble in their general form, by having, like the veneres, three teeth instead of only one under the beaks.

Type. *Cypricardia Guinaica*‡. (Chama oblonga. *Linn.*)
Shell oblong, obliquely angular, decussately striated, light mud colour ; anterior side compressed towards the extremity ; apex rounded.

Coast of Guinea. 7 Species. Pl. vi. Fig. 61.

* *Allied to the Cardium.* † *Furrowed.* ‡ *From Guinea.*

4. Hiatella*.

Shell equivalve, very inequilateral, transverse, gaping at the superior margin. Hinge with one small tooth on the right valve, and two, rather larger, oblique teeth on the left. Ligament external.

One species. *Hiatella arctica*†. (Mya arctica. *Linn.*)

Shell transversely oblong; anterior side the longest; apex truncated; the two angles of the valves muricated; one very oblique; striæ transverse. *North Seas.* Pl. vi. Fig. 62.

5. Isocardia ‡.

Shell equivalve, cordate, ventricose; beaks distant, diverging, involute-spiral. Two flattened, entering, cardinal teeth, one curved and sunk under the beak; one elongated lateral tooth, situated below the corselet. Ligament external, forked on one side.

Type. *Isocardia Cor* §. (Chama Cor. *Linn.*)

Shell cordate-globular, smooth, yellow; nates whitish. *European Ocean, Mediterranean,* &c. 4 Species. Pl. vi. Fig. 63.

7th Family.

Arcacea. (4 genera).

Cardinal teeth small, numerous, entering, and disposed on each valve in a straight, arched, or broken line.

The arcacea are very remarkable by the hinge of their shells, which are equivalve, regular, the beaks commonly distant, the ligament entirely external, and the muscular impressions lateral. Some are transverse, others rounded. Several have a more or less velvety epidermis. Some adhere to rocks by tendinous threads, which the animal fixes to them, and the shell gapes, more or less, at the superior margin.

The Arcacea generally bury themselves in the sand, at a short distance from the shore, and are all sea shells.

* Dim. from *hiatus*—gaping—the little gaper. † *Arctic.*
‡ From ἴσος, equal, and καρδία, a heart. § *Heart.*

1. Cucullæa *.

Shell equivalve, inequilateral, trapezoidal, ventricose; beaks distant, separated by the facet of the ligament. Anterior muscular impression elevated; margin angular, or auriculated. Hinge linear, straight, with very small transverse teeth; from two to five ribs at the extremities, parallel to the hinge. Ligament wholly external.

The cucullææ are large, very tumid, trapezoidal shells, with the anterior side obliquely truncated, forming a broad, cordate, flattened corselet, slightly elevated towards the middle. The hinge is that of the arcæ, but as the shell grows it is displaced, and leaving the remains of its former margins at the extremities, gives rise to two parallel ribs, by which it is terminated, which is not seen in the arcæ. These singular ribs have a very different direction from that of the serial teeth of the hinge, and cannot be taken for teeth. When old, these shells are very thick, and the lateral ribs of their hinge become progressively more numerous. The facet of the ligament also increases in proportion, and becomes more furrowed.

Type. *Cucullæa auriculifera* †. (Arca cucullus. *Gmel.*)

Shell obliquely cordate, ventricose, decussately striated, yellow; hinge on both sides subbicostate. *Indian Ocean.* 2 Species. Pl. vi. Fig. 64.

2. Arca ‡.

Shell transverse, subequivalve, inequilateral, beaks distant, separated by the facet of the ligament. Hinge linear, straight, no ribs at its extremities, and furnished with numerous serial, entering teeth. Ligament wholly external.

The Arcæ are sea shells, and readily known by the peculiar form of their hinge. They are generally very inequilateral, almost rhomboidal, and remarkable for the distance between the beaks of most of them. When placed on the superior margin they resemble a boat, especially those which are transversely

* From *Cucullus*, a hood. † *Having ears; auriculated.*

‡ *A Chest or Ark.*

elongated, whence their name. They often gape at the superior margin, in consequence of the tendinous fibres which the animal puts out at that part to fix them to the rocks.

The space between the beaks forms a romboidal, flat, or somewhat hollow facet, which receives the ligament. The facet is marked with furrows, which form lozenge-shaped figures when the valves are closed. Two muscular impressions are visible at the sides, in the interior of the shell.

The Arcæ live near the coasts, some buried in the sand, others on the surface. Several have a scaly or velvety epidermis.

This species is subdivided into (1) shells whose superior margin is not crenate within,—23 species; and (2) those with the superior margin internally crenate,—14 species.

Type. *Arca tortuosa**. (Idem. *Linn.*)

Shell distorted, parallelopipedal, striated; valves obliquely carinated; nates small, curved. *Indian Ocean.* In all 37 recent species, and 9 fossil. Pl. vi. Fig. 65.

3. Pectunculus†.

Shell orbicular, almost lenticular, equivalve, subequilateral, close. Hinge arched, furnished with numerous serial, oblique, entering teeth, the middle ones obsolete, nearly obliterated. Ligament external.

The pectunculi are distinguished from the arcæ by the orbicular form of their shells, and especially by the hinge being arched, instead of straight; the teeth also are less numerous, farther apart, and larger, and they never gape. The foot of the animal appears to be securiform, and lobed. It has no projecting tracheæ. The beaks of the shell are not very distant from each other, yet are always separated by an external, narrow, angularly-furrowed, rather hollow facet, to which the ligament is attached, and which distinguishes the pectunculi from the nuculæ, whose ligament is partly interior, and which have no facet between the beaks.

* *Crooked.*

† An original term, the name of a sort of shell-fish.

The shells of this genus are marine, and resemble the pectines in form, and by the internal margin being always crenate. Many species acquire considerable thickness by age, and experience such a change of form as renders it difficult to distinguish them.

The species are subdivided into (1) Shells with distant longitudinal furrows, and frequently, in addition, delicate transverse or longitudinal striæ—14 species; and (2) Those with prominent and radiating longitudinal ribs, with or without transverse striæ—5 species.

Type. *Pectunculus glycimeris.* (Arca glycimeris ? *Linn.*)

Shell orbicular, transverse, subequilateral, longitudinally furrowed and striated; when old, turgid, and very thick; obscure transverse zones. *Mediterranean and Atlantic Ocean.* In all, 19 recent species, and 9 fossil. Pl. vi. Fig. 66.

4. Nucula*.

Shell transverse, ovate-triangular, or oblong, equivalve, inequilateral. No facet between the beaks; line of the hinge broken or angular, many-toothed, interrupted in the middle by a pit, or spoon (cochlea) extending obliquely; teeth numerous, often produced like those of the pectines. Beaks contiguous, curved backwards. Ligament marginal, and partly internal, inserted in the pit or spoon of the hinge.

The nuculæ are distinguished from the pectunculi and arcæ, not only by the broken or angular line of their hinge, but also by the ligament, which is partly internal, and by wanting the facet between the beaks. They are small sea-shells, somewhat triangular, and more or less pearly on the inside.

Type. *Nucula rostrata*†. (Arca rostrata. *Brug.*)

Shell transverse, oblong, rather convex, thin, transversely striated; anterior side longest, attenuated, beaked. *Baltic Sea.* Six recent species, and 4 fossil. Pl. vi. Fig. 67.

* *A small nut.*

† *Beaked.* Lamarck's second species. His type is *N. lanceolata.*

8th Family.

TRIGONIANA. (2 Genera.)

Cardinal teeth lamellar, transversely striated.

The shells of this family which embraces but two genera, are free, regular, equivalve, inequilateral, ribbed longitudinally or transversely, and are remarkable by their lamellar and transversely striated cardinal teeth, which differ from those of the arcacea, by the striæ being on separate laminæ, instead of being on the hinge itself.

1. Trigonia*.

Shell equivalve, inequilateral, triangular, sometimes suborbicular. Cardinal teeth oblong, flattened at the sides, diverging, transversely furrowed; two on the right valve furrowed on both sides, four on the other furrowed only on one side. Ligament external, marginal.

The trigoniæ are regular, free, very inequilateral sea-shells, and all, except one species, only known in the fossil state.

Type. *Trigonia pectinata* †.

Shell suborbicular, radiately ribbed; internally pearly; ribs prominent, ventricose, rather rugged; margin plicate. Externally it resembles a pecten without ears. *New Holland.* Recent, 15 fossil species. Pl. vi. Fig. 68.

2. Castalia ‡.

Shell equivalve, inequilateral, triangular; beaks eroded, curved backwards. Two lamellar cardinal teeth, transversely striated; one posterior, distant, shortened, sub-tri-lamellar; the other anterior, elongated; lateral ligament external.

The castalia resembles a trigonia in appearance, but differs from it by the number and situation of its teeth, which have more resemblance to those of the unio, between which and the trigonia it seems to be intermediate. It appears to be a river shell.

* From τρεῖς, three, and γωνία, an angle.

† *Comb-shaped, resembling a pecten.*

‡ *A name in fabulous history. The daughter of Achelous, who was changed into a fountain.*

One species. *Castalia ambigua**.

Shell oval, triangular, tumid; anteriorly obtuse, cordate, longitudinally ribbed; ribs rather flat, transversely striated, and not extending to the superior margin, Epidermis brown; margin entire; internally brilliant-pearly. *New Holland.*

Errata in first part of this Paper.

Page 79, line 2, *for* open and shut them, *read* to open them when shut.
„ 81, „ 24, *for* Myaria. (3 Genera,) *read* Myaria. (2 Genera.)

[To be continued.]

Art. VI. *Extracts from the Meteorological Journal of* Signor Mario Gemmellaro, *of Catonia, in Sicily.*

[We have been favoured by a Correspondent with the original journal of Signor Gemmellaro, from which we have made the following extracts.]

In the year 1804, a sensible earthquake occurred on the 9th February, Etna emitted smoke ninety-seven days, but no eruption took place. The lowest degree of temperature at Catania was 47°, the highest 90°. No thunder.

In 1805, an earthquake occurred on the 3d July. The mountain emitted smoke 47 days, flamed 28 days, and an eruption took place in June, within the great crater. No thunder. Lowest temperature 48°, highest 90°.

In 1806, two earthquakes, *viz.*, on the 27th May and 10th October. The mountain smoked 47 days, flamed 7 days, and detonated 28 days. A litrle thunder. Lowest temperature 44°, highest 90°.

In 1807, two earthquakes, *viz.*, on the 24th February and 25th November. Etna smoked 59 days. Very little thunder. Lowest temperature 44°, highest 93°.

In 1808, many sensible earthquakes on various days of August and September, and in all December, and the mountain detonated at the same times. It emitted smoke only 12 days, but flamed 102 days. Several thunder storms. Four destructive waterspouts at Nicolosi and at St. Nicolo l'Arena. Lowest temperature 30°, highest 95°.

* *Doubtful.* An unique shell, in the possession of M. le Marquis de Dree. We do not know that any figure of it is published; if we can obtain it, we shall give it in a future number.

In 1809, 37 earthquakes, *viz.*, in January, February, March, April, May, September, and December. The most sensible were those of the 27th March, on which day the mountain sent forth an eruption on its west side which lasted 13 days, having damaged a part of the Bosco di Castiglione, and extended as far as Linguagrossa. It smoked 152 days, flamed 3 days, and detonated 11 days. Little thunder. A waterspout on the 6th October, caused a storm in the vicinity of Belgrasso and Nicolosi. Lowest temperature 43°, highest 97°.

In 1810, 4 earthquakes, *viz.*, on the night of the 16th and day of the 17th of February, the first of which was preceded by a rumbling noise, sensible throughout Sicily, in Malta, on part of the African coast, and in Cyprus; but no eruption of the mountain occurred. It smoked 21 days, flamed 6. Little thunder. Lowest temperature 38°, highest 99°.

In 1811, numerous slight earthquakes took place, but one on 27th March was sensible every where in Sicily. After a rumbling noise had been heard for two days, the mountain opened its east side on the 27th October, and eructed a current of lava, which flowed into the Valley del Bue, which still continues, (in January, 1812). About 20 thunder showers have occurred this year. Lowest temperature 41°, highest 92°.

In 1812, no earthquakes. Etna continued to hold its east side open, by which an enormous flow of lava issued, and a hill, or mountain, was formed, called at Catania Mount St. Simon, until the 24th April, after which period the mountain smoked a little during 6 days. No thunder. Lowest temperature 37°, highest 93°.

In 1813, two earthquakes, *viz.*, on the 3d and 13th March. The mountain smoked 28 days. On the 30th June and 5th August smoke was emited from the new mount St. Simon. In a storm on the 10th of January, a strong scent of ammonia was perceived at about three hours after sunset. And in another storm on the 15th March, the rain had an orange colour, was acrid, and yielded an orange-coloured precipitate. It fell during a south wind, after two days of cloudy weather. The quantity of rain fallen by the pluviometer was unusually large

this year. 21 thunder storms. Lowest temperature 28°, highest 102°.

In 1814, one earthquake on the 3d November, preceded by a silent but sudden discharge of *sand* from the part of the mountain called the Zoccolaro, and from a part of the Timpa del Barile. Etna smoked 5 days only. On the 2d of June a phenomenon occurred, quite unexampled here. The air became sonorous, producing a whistling noise, which could be modulated by motions of the fingers. This was mentioned in the Italian and French journals. Two waterspouts occurred at Nicolosi, *viz.*, on the 18th June and 29th November. Lowest temperature 37°, highest 88°. 12 Thunder storms.

In 1815, an earthquake on the 6th September. Etna smoked 42 days. A waterspout on 6th January. 11 thunder storms. The effects of lightning on the 6th, 7th, and 11th of January were most tremendous. The spires of the churches at Nicolosi, at Pedara, at Stell' Arragona, the light-house at Messina, the castle at Sylla, &c. &c., were struck.

In 1816, no earthquakes. The mountain smoked 27 days. On the 13th August, a loud noise was heard, occasioned by a portion of the interior side of the great crater having fallen. 10 Thunder storms.

In 1817, an earthquake on the 18th October. The mountain smoked 22 days. 8 Thunder showers.

In 1818, 25 earthquakes. The greatest (a destructive one,) in the neighbourhood of Catania, was on the 20th February. Etna smoked 24 days. No thunder. Greatest heat 96°.

Signor M. Gemmellaro's Register of Thermometric Observations, made contemporaneously every morning, noon, and evening, at Catania, at Nicolosi, and at the house on Etna, between the 30th of June and 5th of September, of the year 1811, gives the following results, *viz.*,

The mean temperature of this period, at Catania, was $83\frac{14}{51}$°; at Nicolosi, $77\frac{3}{11}$°; on Etna, $43\frac{1}{25}$°. Therefore the difference between the climate of Catania and that of Nicolosi was $6\frac{208}{561}$°; between Nicolosi and Etna, $34\frac{64}{275}$°; between Catania and Etna, $40\frac{374}{1275}$°.

Art. VII. *On the Advantages of the Curvilinear Form introduced by* Sir Robert Seppings, *in the Construction of the Sterns of British Ships of War. By* John Knowles, Esq., F.R.S.

To examine with caution, and, indeed, with prejudice, every deviation from that which has been established by custom, seems to be a natural operation of the human mind; hence, it has been the fate of almost all the important improvements which have been introduced in science or in art, to meet with opposition from the prejudiced in favour of former practices, as well as from those who consider that their private interests are likely to be sacrificed by the change.

With such feelings some persons have viewed a recent improvement in the practice of naval architecture, that of giving to the sterns of our ships of war a curvilinear form, and have, consequently, indulged in asperity of criticism, which has, however, only tended to shew their ignorance of the system.

To prove the advantages which arise from this innovation, Sir Robert Seppings has recently printed and privately circulated a letter addressed to Viscount Melville, which, if published, would leave but little to add to the inquiry; but as this is not the case, it is considered that a description of these (which have usually been called circular) sterns, and a statement of the advantages arising from them, founded chiefly upon the facts adduced by Sir Robert, will not be unacceptable to the public.

But before we enter upon this description, it will be necessary to give, in order to elucidate the subject, an historical sketch of the manner in which the sterns of ships have hitherto been constructed, and we shall commence our inquiry at the reign of Henry VIII., a period when the fancies of speculation gave way to the delineation of the artist.

In the 16th century the sterns of the ships of the largest class were formed square, not only above, but for some feet below, the line of water, and were adorned with carved work and ban-

ners. The shape of these sterns admitted of four guns of large calibre, being fired right aft. We learn from the picture preserved in the Society of Antiquaries, of the embarkation of Henry VIII. at Dover, in the year 1520, (which, no doubt, was painted at the time, but has been incorrectly ascribed to the pencil of Holbein,) that ships at that period had neither stern-walks, balconies, nor quarter galleries, nor is there represented the convenience of a water-closet abaft, even in the ship occupied by His Majesty; and but one only in the squadron, which is in a ship bearing the royal standard, and which it is evident, from the colouring, was an appendage for the occasion, and probably put up for the accommodation of the Queen of England, and her court. The sterns of these ships were, no doubt, formed by several beams of considerable dimensions, called transoms, lying horizontally, and attached to their frames or ribs, by large crooked pieces of timber called knees; these, it would seem, prevented the working of the guns in the quarters to any effect.

In the beginning of the 17th century our ships of war were much improved, not only by an increase of their dimensions, but also by the application of science to the construction of their bodies; fortunately this opinion does not rest upon mere speculation, Sir Robert Seppings having in his possession a complete draught of the Sovereign, launched in the year 1637. This ship was designed by Mr. Phineas Pett, to whose memory the civil departments of the navy owe much for his scientific knowledge and judicious arrangements: this, then, may be regarded as the era when the body of a ship was constructed upon scientific principles. It appears that Mr. Pett had, previously to his becoming a naval architect, taken the degree of Master of Arts, at the University of Cambridge; and the excellency of this drawing, and the wide range of improvement in a short period, shew the great advantages that are derived by a combination of mathematical learning, with practical architecture. The stern of the Sovereign is improved by being rounded below and a little above the seat of water; she had five transoms, and stern and quarter galleries, or balconies; her draught of

water abaft was twenty-two feet three inches, the height of the stern above the water fifty feet nine inches, and she originally had six decks or platforms abaft, on which guns might be carried. Contemporary writers say, that "she was built for shew and magnificence, but that being taken down a deck lower, she became one of the best men-of-war in the world." The only deck which could have been removed was the top-gallant round-house, or poop-royal, as it is sometimes called, which, by lowering the stern about six feet, no doubt, would render her a better ship for sea purposes. This opinion is founded upon official documents, for it appears the Sovereign was always considered a first-rate until taken to pieces to be rebuilt. It is worthy to be placed upon record, that it was not only the sterns of ships, at the period of which we are speaking, that were overloaded with ornaments, but the heads also, for the prow of this ship extended forty-three feet six inches from the line of fluitation, and was covered with massive carved work.

The cumbrous and expensive mode of building and ornamenting the heads and sterns of ships of the first class, continued until the year 1699, when directions were given by the government "to be more sparing in the carved work, and other decorations." The balconies in the quarters were, however, fitted until the year 1729, when these projections were discontinued, and close galleries adopted.

To lower the height, and to lessen the weight, of the sterns in large ships, the poops royal were omitted in those built and repaired after the middle of the last century. From this period little appears to have been done to alter or amend the heads and sterns of our ships of war, as they still continued to exhibit massive carved work, which was a disgrace to the taste and science of the country, until the year 1796, when Earl Spencer, who carries his scientific knowledge into all the useful concerns of life, being then First Lord of the Admiralty, directed that the ponderous heads should no longer be continued, nor should there be galleries or carved work in their sterns. Although this was a considerable step towards improvement, by reducing the weights in the extremities of ships, nothing was done to render

them stronger in those parts by a different disposition or combination of materials, until the year 1811, when Sir Robert Seppings introduced a method of strengthening the bow, and affording protection to the mariners, by carrying up the timbers so as to form a round bow; and subsequently in June, 1816, he proposed that the same system should be adopted in the stern, a part that still more required to be strengthened, so as to form the circular stern which is the subject of the present essay.

The advantages derived from the circular sterns may be classed under the following heads:-

1st. A considerable addition to the strength of the ships.

2nd. Safety to the people employed in them, both from the effects of a sea striking their sterns, and from shot fired by the enemy.

3rd. The additional means afforded for attack or defence.

4th. The improvement in the sailing qualities of the ships by the removal of the quarter galleries.

The insufficiency in point of strength of the old method of constructing the sterns, is proved in Sir Robert Seppings's letter, by his giving, from official reports, eighty-nine instances in ships of the line, and eighty in frigates, of the great weakness of that part of the ships; many of these were commanded by officers who are celebrated for activity and prowess during the two last wars. This defect being so general, led to the consideration of the best mode of remedying it; and the acknowledged strength of the round bow, a part subjected to the action of far greater forces and strains than the stern, naturally led to the consideration of fortifying the latter by the same mode of timbering, and from this arose the circular stern. Before the introduction of this system, the new mode of ship building might truly be said to be incomplete, for the shelf-pieces and waterways, as well as all the planking above the wing transom, which may be called internal and external hoops, were cut off, and hence left the stern the only weak part in the ship; for it is an axiom in mechanics that the strength of any fabric may be measured by the weakest part, subjected to the like strains or action. It is, then, the mode of timbering these sterns, and a continuity of the in-

ternal and external planking that constitute their strength, and establish the principle; the different methods that may be devised of placing the decorations or accommodations, have little to do with the system, as long as these methods are preserved.

The safety which the present method of constructing the sterns affords to the seamen, over that of the old plan, is best shewn by some instances of the danger arising from the imperfections of the latter method, which, above the wing transom presented little else than glazed windows. The Dictator, of 64 guns, in her passage from the West Indies in the year 1797, was struck by the sea on the stern, which stove in the dead lights and window frames, washed away every thing on the main deck, and the crew were under the necessity of throwing six of the guns overboard to lighten the ship abaft. The Revolutionaire, of 46 guns, on her passage also from the West Indies, in the year 1804, met with a similar accident, which also stove in the dead lights, and carried away the bulkhead of the great cabin; and had not the hatchways been barred down, which prevented the water from getting into the hold, the ship must have foundered.

In the sterns formed according to the old plan the men on all the decks, except those on the lower gundeck in ships of the line, are exposed to the most destructive raking fire, their sterns being pervious even to a musket ball.

The strength given to the circular sterns by carrying up the timbers, prevents all the danger to be apprehended from a sea striking the ship abaft, or from the ingress of small shot, as well as from large ones which have not force to pass through the timbers and planking. And from their curved form, the shocks of the sea abaft will be much lessened, and those shot fired at an angle of, and at more than 45°, will glance off without doing much injury to the ships.

When we consider that according to the present method of constructing the sterns, the guns can be run out in that part, pointed, elevated, or depressed, with as much facility, and in the same manner, that those are in the sides of the ships; and that the fire can be varied in all directions from the semicir-

cular form of the stern, the subject of the means afforded for attack or defence in this quarter need not be further insisted upon; but a most important port for a gun has been added to each deck in the situation that the quarter galleries formerly occupied. The necessity of having guns in this place will be shewn hereafter by some examples of the want of them in the ships built according to the old form; indeed, when an enemy's ship has lain upon the quarters of any vessel, it has technically been called the point of impunity, from the circumstance of their bringing many guns to bear, and their opponent not being able to fire one shot with effect. Sir Robert Seppings has stated, in his letter before alluded to,* that, according to the present disposition of the ports, " a three-decked ship, if attacked abaft, can bring at least ten guns to bear upon her assailant, a two-decked ship eight, and a frigate four."

In the old sterns the guns on the lower gun-decks could not be fired without injury to the ships, from the effects of concussion on their projecting counters; and on the other decks the breadth of the transoms prevented their being run out sufficiently, and the height of those beams above the decks hindered the guns from being depressed.

To prove these facts many instances have been adduced, and among them that of the masterly retreat of Admiral Cornwallis before a French fleet of very superior force; to accomplish this, by annoying the enemy, the ships were obliged to be so mutilated in their sterns, in order to be enabled to fire guns right aft, that on their arrival in port they had to undergo very considerable repairs before they were again considered sea worthy.

Among the many instances on record of the danger arising from the want of guns in the quarters of ships, may be cited the fact, that Admiral Sir Sidney Smith took his station in Sweedish gun-boats, (propelled with oars,) on the quarters of the ships of a Russian fleet, and so annoyed them, that they may be said to have suffered a defeat, arising from the circumstance of their not being able to bring any guns to bear upon those boats.

The weight of the additional timbers placed in the circular

sterns is more than compensated by the omission of transoms, sleepers, and useless decorations, as well as by a less projection of the sterns above water; and as the ships now have the same form below, and for some feet above the line of fluitation, they, consequently, have the same buoyancy abaft as those built according to the old plan. Their sea-going properties are, however, improved by the omission of quarter galleries, which acted as a back sail when the ships were going on a wind.

But it may be said, these advantages appear to be feasible from analogy, but what direct proofs are there from experience that such are derived from the circular sterns? The answer to this is, the Owen Glendower, of 42 guns, was employed for rather more than two years on the South American station; the Aurora frigate is now on that station; and the Ganges, of 84 guns, has lately come from the East Indies; all these ships have circular sterns, of which their commanders have spoken in the most favourable terms. The Ganges, on her passage home, encountered, off the Cape of Good Hope, a gale of wind, twenty-nine days in continuance, and " although the ship was repeatedly wore that she might be longer before the sea, which was tremendous," to try the effects of the shape given to the sterns, " she never threw the water into the ward-room, and not a spray ever wetted the stern-walk."

As the circular sterns have been examined as to all the essential requisites in a ship of war, it remains to be seen how far they may be wanting in external appearance, or internal accommodation. It is difficult to separate the preconceived notion of what a ship was, from what she ought to be; and still more difficult to lay down a rule of what may be deemed beauty in naval architecture, for this at last must be arbitrary. M. Charles Dupin, speaking upon this point, considers beauty to consist in that which is the most fitting for its object, for he says, that stern only " can be beautiful, when the appearance of its force shall command respect from the feelings of the enemy*." If

* " Attaquons surtout ces fausses idées qui font entrer en balance avec la force réelle des bâtimens de guerre, de futiles et vains caprices de goût, d'ornement, de décoration, pour un édifice qui sera d'une beauté parfaite,

this opinion be granted, the circular sterns are, in a high degree, beautiful.

The only apparent difference in size in the Captain's cabin and ward-room is the difference between the overhanging of the old and new sterns; and this is not real, if the area be considered, for the transoms, and their securities, occupied a considerable space. It must be allowed that at present there are less stern windows, but there is still a sufficiency of light and air from those now placed in the stern, as well as from the ports and sky-lights. By the removal of timbers called sleepers, the internal accommodations for the reception of bread is augmented; for the bread-room in a 74 gun ship has 313 cubic feet more of space than in one with the old stern.

The present method of building ships' sterns has gone too far to be shaken by prejudice, or discontinued in consequence of the cavils of those who consider that every thing is to be sacrificed to appearance, or what they vainly imagine personal comforts; and we find that the other naval powers with whom, at no very distant period, we may have to contend, have justly appreciated the plan. The Dutch have altogether adopted this, as well as the other inventions of Sir Robert Seppings. The Americans are now building ships with circular sterns. And the French have either been persuaded into the system by the force of eloquence used by their most elegant and acute writer on naval affairs (Charles Dupin,) or driven into it by the strain of irony with which he has treated the tardiness of the government in adopting what he considers a most important improvement. In consequence of this, French ships have been built with circular sterns, and they have a frigate of the largest class with such a stern, now employed in South America.

Dear bought experience having taught us how dangerous it is to hold an enemy too cheap, or to combat upon unequal terms, establishes the practice, and stamps the necessity of constructing our ships according to that method which shall unite safety with the greatest force that can be brought to bear, in any point, upon the ships of the enemy.

aussitôt que l'aspect de sa force commandera le respect dans l'ame de l'ennemi." *Force navale de la Grande-Bretagne, par* CHARLES DUPIN.

Art. VIII. *Observations on Atmospheric Eletricity made on Vesuvius, in June and July,* 1819. *By* F. Ronalds Esq.

The rod of my electrometer (See *Quarterly Journal*, Vol. II., page 252,) was placed perpendicularly on the highest pinnacle of the mountain, on the north side of the great crater, and at about 500 yards (across a ravine,) distant from it. It was fourteen feet high, and the insulation was very good, for, when electrified *artificially* to a much higher degree than it ever became *naturally*, it retained its electricity for full five minutes, without any sensible diminution. A pair of straws, made exactly according to Volta's standard of the third (or smallest) size was attached to the rod. The *results* were as follow, *viz.*:

The electricity was *constantly* positive.

The intensity increased as the sun rose (as usual), except when influenced by explosions of the volcano, &c. The variations of intensity occurred very frequently. The difference between the highest and lowest degree of intensity amounted to nearly one-third of the mean intensity.

These variations of tension sometimes accompanied changes of wind, which often occurred six or seven times in the course of half an hour. The wind most frequently blew from the south, but often *suddenly* changed to north-east and north.

Sometimes they immediately *followed* explosions from the craters, and sometimes did not seem to be at all influenced by them, or by a wind which came directly from the crater, at the time of an explosion.

Sometimes they were evidently produced by the approach of vapour from an aqueous fumerole, and then the tension was always increased. Sometimes the tension was diminished very rapidly after an explosion, and sometimes increased as rapidly.

The black fumes from the old crater evidently diminished the tension much more frequently than the white, and very rarely increased it.

Finally, it seemed sometimes utterly impossible to discover

any coincident occurrence which could produce these changes; so that perhaps it may be in vain, without further experiments, to attempt any rational explanation of the phenomena. Would it be fair to suppose, that the black fumes may be in a negative state, and that the white fumes, consisting principally of aqueous vapour, sulphuric and muriatic acids, and sulphur, may, when these vapours become condensed, (as in Volta's artificial experiment), and when the sulphur sublimes in the air, be brought into a positive state, and that these two states of the black and white fumes may sometimes act separately upon the electrometer; or sometimes wholly, and sometimes partially, neutralize each other, either by induction or position, or by a discharge from one to the other? In *violent* eruptions, no doubt, the frequent flashes of lightning which are seen to take place amongst the clouds of smoke and vapours proceeding from the crater, are occasioned by such discharges.

The thermometer in the shade, on the mountain, on the 4th July, at 8 o'clock A.M., stood at 76°, and in the sun, with a blackened ball, at 83°. At the same hour at Naples it stood at 78° in the shade, and at 100° in the sun, with a black ball.

The magnetic needle on the mountain never exhibited, with me, any such extraordinary signs of oscillation, as it appears to have done with Spallanzani; neither could M. Gimbernat, Councillor of State to the King of Prussia, (who witnessed some of my experiments on Vesuvius,) ever perceive any such effects, although he frequently tried the experiment. M. Gimbernat is the gentleman to whom visitors to Vesuvius are so much indebted for the luxury of fine pure water in this region of heat, thirst, and fatigue, by the establishment of an apparatus for condensing the water of the aqueous fumerole.

Art. IX. *On an Improved Method of Constructing the Dead Escapement for Clocks.* *By* B. L. Vulliamy, Clock-maker to the King.

[Communicated by the Author.]

The dead escapement originally invented by G. Graham, F.R.S., being perhaps practically the best clock escapement

known, any improvement in the method of executing it, whereby the practice is made more exactly to agree with the theory than has hitherto been the case, may not be unworthy of notice.

The principle of the dead-escapement is well known; the motion of the pendulum is maintained by the action of the wheel on the inclined planes of the pallets, which occupy a portion of the arc of vibration of the pendulum, equal to the angle of the pallets; during the remainder of the vibration, the tooth bears on the circular parts, or rests of the pallets, which are portions of two circles, concentric with the axis of the verge, or centre of motion of the pallets, and consequently there ought not to be any recoil in the escapement, if properly executed. Various constructions and shapes of pallets and pallet-frames, each supposed to possess some peculiar advantage, have, at various periods, been adopted; but the whole have been executed with the file. The construction of the dead-escapement, of which the following is a description, and which I have employed, is, with the exception of the inclined planes of the pallets, and forming the frame out of the turned piece or pieces, entirely executed in the lathe; and if the parts are accurately turned with a slide-rest, must of course possess a degree of precision, independent of its other advantages, which pallets executed with the file cannot possess.

Fig. 1, of which Fig. 2. is a section, represents a circular brass plate, with a square groove, A B, turned in it. Fig. 3, represents a steel ring, of which Fig. 4, is a section, turned very exactly of width and thickness to fit perfectly into the groove A B, portions of which form the pallets. Fig. 5, represents the pallet-frame made out of the circular piece of brass, represented Fig. 1, L and M; Figs. 2, 5, and 8, are two pieces, fixed with screws to the frame to retain the pallets immovably in the grooves. Figs. 6 and 7, represent each a pair of pallets, made of part of the steel ring, the one with short, the other with long, inclined planes; 1, 2, and 3, 4, are the inclined planes of both pair of pallets. Fig. 8, represents the pallets placed in the frame, and held firmly in their places by the pieces L and M. The preferable mode of making the

pieces L and M, is out of the extremity of a piece of what remains of the piece, Fig. 1, after the pallet-frame is formed, reduced to a proper thickness, because the end of the piece is of necessity a portion of the same circle as the end of the arm.

In the common construction of pallets there is no method of opening and closing the pallets to the wheel, but by filing the inclined planes, or faces, of the pallets to open them, and bending the arms to close them; to obviate this inconvenience, jointed pallet-frames have been adopted; but these, unless planned and executed with more than common care, are as defective in principle as in execution. In the construction of the pallets above described, the pallet-frame is not jointed, but made of a single piece, and there is no adjustment in the frame for opening and closing the pallets to the wheel; but the same end may be obtained, though not in the most perfect manner, by loosening the pieces L and M, (see Fig. 8,) by which the pallets are held fast in the frame, and pushing the pallets backwards and forwards in the groove. This, though infinitely better than the old method, is not easy, it being difficult in practice to remove the pallets a very minute quantity; and to open or close the pallets by this method, it is necessary to disengage the pallet-frame, and all the parts to which it is attached, from the frame of the clock, an inconvenience which is entirely obviated by the method about to be described.

To remove this difficulty, the following mode of constructing the pallet-frame may be adopted. It admits of the pallet-frame being made jointed upon the same principle, and with equal accuracy; and the opening and closing of the arms being regulated by a screw, their quantity of motion may be infinitely small, and determined to the greatest nicety. For this purpose a second piece, exactly similar to the piece represented Fig. 1, is required. See Fig. 9, of which Fig. 10, is a section.

When the pallet-frame is intended to be made jointed, the sink E F, represented in the section Fig. 2, must be turned in Fig. 1, on the reverse side to the groove A B, and a similar sink, E F, must be turned in the piece, Fig. 9, on the same side as the groove. See Fig. 10. It is requisite those sinks should

be exactly the same size, and in depth half the thickness of the piece. The two circular pieces, Figs. 1 and 9, being of equal thickness, and the sinks each equal to half the thickness of the piece in which it is turned, it necessarily follows that, when the surfaces of the two sinks are brought together, they will equal in thickness the remaining part of either piece. That this should be the case is indispensable to the correct performance of a jointed pallet-frame, made on this construction. Perhaps the best mode in practice to make the sinks equal, is to turn a piece of brass as a gauge, to let into the pieces, Figs. 1 and 9, which will ensure the sinks being in every respect the same. The section of such a piece is shewn, W, Fig. 10. Exactly half the pallet-frame is formed out of each of the pieces, Figs. 1 and 9, and the two halves are represented Figs. 11 and 12, and the two put together are represented Fig. 13. To strengthen the long arms that carry the pallets, there is to each half of the frame a portion of the original piece left concentric to the sink, which forms a connexion between the upper surfaces of the long and short arms; and to strengthen the long arm it is continued a little below the arm. By this means the strength of the frame is greatly increased, and the fitting together of the two arms does not entirely depend on the good fitting of the holes through their centres, on the steel cylinder, or verge, that passes through the common centre of the two. This is shewn more plainly in Fig. 11, than in Fig. 12, the whole surface of Fig. 12, being on the side represented in the figure on one plane, whereas in Fig. 11, (on the side represented in the figure,) the two arms and connecting part are on one plane, and the sunk part represented by the complete circle on another, half the thickness of the piece below the upper plane. The manner of fixing the pallets to the axis of the verge connecting the two arms together, and opening and closing them, is represented in front, Fig. 15, and in profile, Fig. 14. A A, Fig. 14, is part of the verge, to which is immovably fixed the collet C, with a long socket; D is the pallet-frame, and G a collar in front of the frame. These parts are held together by the two screws X and Y, Fig. 15, which are tapped into the

collar C, Fig. 14, and exactly fit the holes they pass through in the collar G. By this means the two arms forming the pallet-frame are held together, and firmly fixed between the collet C and the collar D, and consequently attached to the verge A A. It is to be observed, that the screws X and Y must not be screwed so tight that the regulating screw, H, has not power to overcome the friction of the arms of the pallets between the collet C and the collar G, for in that case the whole intention of the jointed pallet-frame would be frustrated. To enable the arms to open and close, there are two circular notches in the same places in each half of the pallet-frame, concentric with the centre, (see Figs. 11, 12, and 13,) through which the two screws X and Y, Fig. 15, pass, and the quantity of motion of the arms is determined by the length of the circular notches. The two studs F and F, Fig. 15, through which the regulating screw, H, passes, are connected with the upper arms of the pallets by pivots, which pass through them, and are held in their places with collets and screws.—See Fig. 14. Care must be taken not to screw the studs so tight as to prevent their turning on their centres, otherwise the regulating screw, H, will be bound. This screw, H, being of two different threads, the one coarser than the other, thereby producing a very fine motion, has the effect, when turned in one direction, to open the pallets; and turned in the other, to close them.

The great advantages in this mode of construction are, 1st, That the rests of the pallets are correct portions of circles, the centre of which circles is the centre of motion of the axis of the verge, and the pallets move in the same circles, and, consequently, there will not be any recoil in the escapement. 2d, That the pallets must be of equal thickness, and consequently the drop the same on both. 3d, That the pallets may be made perfectly hard, if properly treated, without risk of altering their shape: and should a pallet be spoiled by any accident in hardening, or a flaw or imperfection of any kind be discovered, another exactly similar is easily made to replace it out of the original ring. When the pallets are made out of the same piece of steel as the arms of the frame, it is difficult to preserve their

shape correctly in hardening, and to retain the acting part of the pallet perfectly hard. To obviate this difficulty, the pallet has sometimes been made a separate piece, with a short arm, by which it is fixed with two screws to the arm of the frame; but this is only to exchange one evil for another, for, independent of other disadvantages, which it is unnecessary to enumerate, it is very uncertain, with the pallets fixed in this manner, whether or not the rests of the pallets are concentric with the centre of the axis of the verge. The slightest deviation from its original direction in the arm of the pallet, by hardening or any other cause, has the effect of removing the centre of the circle, forming the rests of the pallets, from the centre of the axis of the verge to some other place, the consequence of which is to render the escapement a recoil escapement. 4th, That the mode here recommended of constructing the pallets, offers a great facility for making the inclined planes of the pallets equal to one another, or of altering them as may be required; and consequently the angle which the pendulum is led by one pallet, will be equal to the angle it is led by the other.

Figs. 14 and 15, as before mentioned, represent the jointed pallet-frame in profile and in front, with all its parts complete, attached to the verge, and the pallets in their places. To Fig. 15 is added the scape-wheel, and the pallets are represented in the situation in which they will appear, when the wheel has led the pallet to the extremity of the lead. The angles of lead (more particularly noticed hereafter,) of the pallets being each supposed equal to an angle of 2°, it follows that the pendulum is led 1° on each side of the perpendicular line O P, by the action of the escapement, and that the wheel will escape when the pendulum vibrates the smallest quantity more than 1° on each side of the line it subtends when at rest. Now, supposing the total arc of vibration of the pendulum to be 5°, that is, 2° 30′ on each side of the perpendicular, and the angle of lead of the pallets 2°; the tooth of the scape-wheel rests 3° on the rests of the pallets, 1° 30′ on each rest, during each vibration of the pendulum, the pendulum vibrating an angle of 5°. From the above, the great importance of the rests of the pallets being concentric to the

centre of motion of the axis of the verge, is sufficiently obvious. The line O P, Fig. 15, passing through the centres of the axis of the verge and the axis of the wheel, is the line the pendulum subtends when at rest, and the lines A R and A T, forming together the angle R A T, supposed of 2°, are the lines the pendulum will subtend, when led to the extremity of the lead by the action of the wheel upon each pallet. In Fig. 15, the pendulum is supposed to subtend the line A T.

The following is a brief description of a method by which the inclined planes of the pallets are finished to the required angle.

Fig. 16 represents a brass plate, about three or four inches in diameter, the size is not very material, and about two inches thick, with a groove turned in it similar to the groove A P, Fig. 1. The angles B A C and D A E are drawn equal to the proposed angles of lead of the pallets, and in this case are supposed angles of 2°. To determine the line of the face of the inclined planes of the pallets, from the points G and H, where the lines A B and A D intersect the exterior circle of the groove, draw the lines G I and H K, which may be considered as chords subtending equal arcs, intersecting the lines A C and A E, at the points L and M, on the inner circle of the groove; the lines G L and H M may, relative to the two circles of the groove, be considered as representing the inclined planes of the pallets. Now supposing that portion of the original piece of brass subtended by the chord X Y, carefully removed, and the surface made perfectly flat, and at right angles to the turned face in which is the groove, it follows that a piece of the steel ring, Fig. 3, one end of which has been brought by filing very near to the required angle, may be placed in the groove, and ground and finished in the most accurate manner. By this method the surface of the pallet will be made perfectly correct. The other pallet may be finished by a similar method.

It may not be unnecessary to observe, for the preservation of the figure, that the principal bearings of the tool should not come in contact with the grinding surface during the operation.

Art. X. *Observations on the Effects produced by the Bile, in the Process of Digestion, in a Letter to the Editor.* By B. C. Brodie, Esq., F.R.S., Professor of Anatomy and Surgery to the Royal College of Surgeons, &c.

Dear Sir,

I send you a brief history of some experiments relating to the uses of the Bile, which I made a few years ago, and which I mentioned in my lectures delivered in the Theatre of the Royal College of Surgeons during the last spring. They form a part of a series of experiments relating to the function of digestion. I hope on some future occasion to be able to lay the rest of the investigation before the public, but it is not in a state of sufficient forwardness for me to venture to do so at present.

Various opinions have been entertained by physiologists respecting the office of the liver. Some have supposed that the secretion of bile is merely excrementitious; others that the bile is intended to stimulate the intestine, and to produce a ready evacuation of the fæces; and another opinion has been, that the bile is poured out into the duodenum, that it may be blended with the chyme, and, by producing chemical changes in it, convert it into chyle. The situation of the liver, connected as it is in every instance with the upper part of the alimentary canal, is unfavourable to the first of these hypotheses; but the last is rendered very probable by the circumstance of chylification taking place just at the part where the bile flows into the bowel.

In order that I might arrive at some satisfactory conclusion on these points, I applied a ligature round the choledoch duct of an animal, so as completely to prevent the bile entering the intestine, and then noted the effects produced on the digestion of the food which the animal had swallowed, either immediately before or immediately after the operation. The experiment was repeated several times, and the results were uniform. Before I describe these results, it may be proper to make one further

observation. The application of a ligature round the choledoch duct is easily accomplished, and with very little suffering to the animal; so that any derangement in the functions of the viscera, which follows, cannot reasonably be attributed to the mere operation. The division of the stomachic ropes, or terminations of the eighth pair of nerves on the cardia of the stomach, and the ligature of the whole extremity of the pancreas, are operations of much greater difficulty; yet it has been ascertained that neither of these at all interfere with the conversion of the food into chyme, or that of the chyme into chyle.

When an animal swallows solid food, the first change which it undergoes is that of solution in the stomach. In this state of solution it is denominated *chyme*. The appearance of the chyme varies according to the nature of the food. For example, in the stomach of a cat the lean or muscular part of animal food is converted into a brown fluid, of the consistence of thin cream; while milk is first separated into its two constituent parts of coagulum and whey, the former of which is afterwards re-dissolved, and the whole converted into a fluid substance, with very minute portions of coagulum floating in it. Under ordinary circumstances, the chyme, as soon as it has entered the duodenum, assumes the character of *chyle*. The latter is seen mixed with excrementitious matter in the intestine; and in its pure state ascending the lacteal vessels. Nothing like chyle is ever found in the stomach; and Dr. Prout, whose attention has been much directed to the chemical examination of these fluids, has ascertained that albumen, which is the principal component part of chyle, is never to be discovered higher than the pylorus. Now, in my experiments, which were made chiefly on young cats, where a ligature had been applied so as to obstruct the choledoch duct, the first of these processes, namely, the production of chyme in the stomach, took place as usual; but the second, namely, the conversion of the chyme into chyle, was invariably and completely interrupted. Not the smallest trace of chyle was perceptible either in the intestines or in the lacteals. The former contained a semi-fluid substance, resembling the chyme found in the stomach,

with this difference, however, that it became of a thicker consistence in proportion as it was at a greater distance from the stomach: and that, as it approached the termination of the ileum in the cæcum, the fluid part of it had altogether disappeared, and there remained only a solid substance, differing in appearance from ordinary fæces. The lacteals contained a transparent fluid, which I suppose to have consisted partly of lymph, partly of the more fluid part of the chyme, which had become absorbed.

I conceive that these experiments are sufficient to prove that the office of the bile is to change the nutritious part of the chyme into chyle, and to separate from it the excrementitious matter. An observation will here occur to the physiologist. If the bile be of so much importance in the animal economy, how is it that persons occasionally live for a considerable time, in whom the flow of bile into the duodenum is interrupted? On this point it may be remarked, 1st, That it seldom happens that the obstruction of the choledoch duct from disease is so complete as to prevent the passage of the bile altogether; and the circumstance of the evacuations being of a white colour, may prove the deficiency, but does not prove the total absence of bile. 2dly, That in the very few authenticated cases, which have occurred of total obliteration of the choledoch duct in the human subject, there has been, I believe, always extreme emaciation, shewing that the function of nutrition was not properly performed. 3dly, That the fact of individuals having occasionally lived for a few weeks or months under these circumstances only proves that nutrition may take place to some extent without chyle being formed. In my experiments I found that the more fluid parts of the chyme had been absorbed, and probably this would have been sufficient to maintain life during a limited period of time.

In the prosecution of this inquiry, a circumstance occurred, which seems not unworthy of notice, although not immediately connected with the subject of digestion. The ligature applied round the choledoch duct was always a single silk thread, the ends of which were cut off close to the knot. If the animal was allowed to live, he became jaundiced. The *tunicæ*

conjunctivæ of the eyes were tinged with bile, and bile was seen in the urine. But at the end of seven or eight days, I found, in several instances, that an effort was made by nature to repair the injury done by the operation, and to restore the passage of the bile into the intestine. In these instances, on destroying the animal at the end of the above-mentioned period, and exposing the cavity of the abdomen, and then making an opening into the duodenum, I ascertained that on compressing the gall bladder the bile flowed out of the orifice of the choledoch duct in a full stream, in spite of the ligature. On further dissection, I found that a mass of albumen, (coagulable lymph,) had been effused, adhering to the choledoch duct above and below the ligature, and to the neighbouring parts, and enclosing a cavity in which the ligature was contained. The pressure of the latter had caused the duct to ulcerate, without adhesion having taken place of the surfaces which had been brought into contact; and the ligature, having been separated from it by ulceration, lay loose in the cavity formed by the albumen which had been effused around it. Into this cavity the bile might be made to flow from the upper orifice, and out of it into the lower orifice of the choledoch duct; and thus the continuity of the canal intended for the passage of the bile was restored. It is still more remarkable that the same thing happened even when two ligatures had been applied on the choledoch duct at some distance from each other.

The physiologist will not fail to observe the difference between the effects produced by a ligature applied to an excretory tube and a ligature applied to an artery or vein. A circumstance nearly corresponding to that which I have now mentioned, has been noticed by Mr. Travers, respecting the consequences which follow the application of a ligature round the intestine*.

I remain, dear Sir,

Yours, &c.,

December 9, 1822. B. C. Brodie.

* See an Inquiry respecting the process of Nature in repairing Injuries of the Intestines. By B. Travers. London, 1812.

ART. XI. *Some Hints on a Mode of procuring Soft Water at Tunbridge Wells, and on the Danger of the improper Use of its Mineral Springs; with Incidental Observations on Lead.* By G. D. YEATS, M.D., F.R.S., Fellow of the Royal College of Physicians; *in a Letter to the Editor.*

DEAR SIR,

IT has always been a complaint of the visitors to that beautiful watering-place, Tunbridge Wells, that they have found it extremely difficult and troublesome to procure good and pure water for various domestic purposes. In addition also to the comforts and advantages which would be derived from the possession of soft water for household uses, for it is the hardness of the water which is complained of, it is a matter of considerable consequence to many invalids who resort to the Wells for the balminess and salubrity of its air, and for the beauty of its scenery, to be able easily to procure a water free from some saline impregnations which give it qualities noxious to them on account of the complaints under which they may labour. It is very generally known to the public that the salutary effects of the mineral springs at the Wells, for the benefit of which the majority of invalids resort thither, are owing to iron, which exists in the form of a carbonate; but as very many invalids also make a summer visit to this delightful spot, in whose complaints a water with chalybeate properties is not only useless, but positively injurious; and as almost all the common water which is used there, as far as I know, is more or less impregnated with iron, it becomes a matter of great moment, in all points of view for domestic purposes, to procure it free from this active and salutary, but when improperly used in certain conditions of disease, dangerous mineral. Upon sinking a well on some property which I have recently purchased at Tunbridge Wells for a supply of water to the house, I was told by some of the residenters, and I was apprehensive that it would be the case from what I knew of the qualities of the water generally and of the mineral nature of the country, that the water would be very hard and chalybeate, and therefore unfit for some domestic

uses, such as for washing and making tea. When I had, therefore, sunk the well to the depth sufficient to get water, which did not appear till I had got down to above sixty feet, I accordingly found that it was hard and chalybeate; I had not the scientific chemical tests for delicate examination, but it curdled the soap, was harsh and rough to the hands in washing, and not only precipitated upon standing a brownish ochreous powder, but a piece of linen washed in it exhibited, when dry, a brown stain, clearly owing to the iron, and called by the washerwomen *iron mould;* and tea made with it acquired a dark colour, and a rough taste. These circumstances I believe to be the case with almost all the well and pump water of this place. The consequence is, that very many people, especially in dry seasons when the water is undiluted from the land springs by rain, are obliged to buy soft water from men who go about with carts to sell it.

Upon reflecting in what manner these inconveniencies could be remedied, it occurred to me, as the iron was dissolved in the water in the state of a carbonate, and if the hardness of the water was solely owing to the carbonic acid, that at a very trifling expense, and without any difficulty, both the iron and the carbonic acid could be got rid of, and the water thus rendered perfectly useful, and good for all purposes.

As the carbonic acid is in a loose state of combination, it is easily disengaged by heat; it is therefore clear that the process of boiling the water would soon disengage it; but as this would also render the water vapid to the taste, and would be very inconvenient, and expensive in a large way, I felt satisfied that if the water were not immediately used on being taken from the well, but suffered to remain for a time in a cistern, the carbonic acid would be dissipated in its usual state of gas, and that the oxide of iron, thus rendered insoluble by being freed from its acid, would be in the greater part precipitated, and that whatever small portion was suspended would be readily got rid of by filtration, and that thus I should not only have a good and pure water for every purpose, but that others at Tunbridge Wells who suffer from the same incon-

veniencies would be equally benefited by being made acquainted with the cause of the hardness, provided the carbonic acid were found, upon experiment, to be the sole cause of it, for I need scarcely add that other acids, combined and free, are also the cause of the hardness of waters, by disengaging the alkali from the oil in soaps. I therefore, with no little alacrity, set to work to ascertain the fact, and I was soon confirmed in the correctness of the opinion I had formed.

I took some of the water, not recently drawn from the well, but which had remained in an open cistern twenty-four hours, and poured it into a stone filtering jar; this jar is divided into three compartments, the top one in which the water is first placed, the centre one intò which a piece of sponge is pretty tightly crammed, the bottom of this division being pierced with pin-holes to suffer the water to escape into the third compartment below, after it has past through the sponge. Upon mixing soap with some of the water filtered in this simple, easy, and expeditious way, I was extremely well pleased to find that it was become soft. I was now, therefore, sure that the inconvenient degree of hardness was owing to the carbonic acid; but being desirous that a more able and experienced chemist should, in a better way, ascertain, beyond doubt, the ingredients of the water thus filtered, I brought some of it to town and requested Mr. Faraday, of the Royal Institution, to analyze it, and he very obligingly sent me the following satisfactory answer.

Royal Institution,
October 10, 1822.

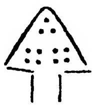
SIR,

I have examined the water attentively, and find *no iron* in it. It is by no means abundant in saline matter, containing only a little muriate and sulphat of soda and lime. There is no carbonic acid or magnesia in it.

I am, &c. &c.

Upon ascertaining the fact that the hardness of the water depended upon the carbonate of iron from which it might be freed by not being immediately used when drawn, and by sub-

sequent filtration, I would not suffer any cock to be fixed to the pump, but had a proper lift and force pump put down to force the water into an open cistern in the house, where it would remain for some time before it was drawn off from the pipe inserted in the bottom of the cistern, and ending with a stop cock. In this way no water could be used before time was allowed for the escape of the carbonic acid, and for the precipitation of the iron; but as the iron in being precipitated to the bottom of the cistern would readily pass off with the water drawn from the conveying pipe and render it thick, and therefore unfit for use, I directed a cone-shaped instrument to be made, pierced with very minute holes, as a strainer, and with a stem about three inches in length, thus



The stem was tightly fixed into the hole of the conveying pipe, and as the strainer was two or three inches above the bottom of the cistern, the iron in being precipitated would fall below it, and would not pass off with the water; but as some of the iron in a state of suspension might, nevertheless, still escape through the strainer, I shall have one made in such a way as to allow of a piece of sponge, of sufficient size to fill its cavity, being put into it. An abundant supply of soft water will be thus easily procured for every domestic use, and freed likewise entirely from the iron which will be arrested in its progress to the conveying pipe by the sponge in the strainer: the water remaining in the cistern, does perfectly well for the offices in the house, to which it is conveyed by another pipe. Upon a trial of the strainer, even without the sponge, it was pleasing to observe the water come out clear from one pipe, while from the other it was thick, as was believed would be the case. Thus, with scarcely any trouble, and at the most trifling expense, an abundant supply of soft water may be had, and to make security doubly sure, the water might be subsequently filtered in a stone jar, for drinking. As almost all the water used at Tunbridge

Wells, for domestic purposes, is taken immediately from the draw-well, or pump, when wanted, it would be worth the trouble, with those who use such water, to ascertain upon what the hardness depends, and in what state of combination the steel exists; and if existing in the way already stated, they would readily get good soft water by the means suggested above.

As my summer residence at Tunbridge-Wells has made me acquainted with many invalids who have occasionally resorted thither, under an erroneous notion that from feeling weak they would be benefited by the strengthening powers of the chalybeate spring, I take this opportunity of stating that I have witnessed a good deal of mischief, from an improper and incautious use of the chalybeate water. Although the iron contained in a given quantity of the water is very small, yet in many cases it acts as a powerful, and sometimes an injurious, stimulus. The kinds of disease which I have found induce patients, very imprudently, to take these waters, have been some chronic affections, dependant upon preternatural fulness, coughs supposed to arise from a morbid state of the stomach, when the pulse has shewn no acceleration, and some affections of the head, called nervous. In these cases, inflammation of the lungs, disposition to apoplexy, *&c.*, have been brought on. Too much caution, therefore, cannot be used by persons who are desirous of drinking these waters, before they properly ascertain the precise nature of their ailments.

While upon this subject, I may as well mention some particulars which occurred, while the men were sinking the well from which the water was procured. It was necessary to cut through a considerable quantity of very hard rock of different qualities: below the surface of the soil, the first substance met with was clay, about two or three feet thick: the men then came to a hard sandstone, and after this there was a stratum of hard blue limestone, which, upon exposure to the air for several days, became of a very light colour, nearly white, and crumbled into powder. There were alternate strata of this limestone and soft blue marl of an unctuous feel, evidently the

same stone, in a less compact or condensed state. In the centre of some of this hard limestone I frequently found pieces of carbonaceous or coaly matter, clearly of ligneous origin, from its fibrous appearance; it burnt very well in the fire. In the middle of the stones was also found what appeared to be the impression of leaves, evidently proving that the stone must at one time have been of much softer consistence. Whenever the well-digger came to this soft marl, he was prevented from going on with his work, by an immense quantity of carbonic gas, which issued from it, and so powerful and continued was the supply of this deleterious air, that a strong fire was made in a kind of chimney constructed for the purpose, and which was connected with an air-tight shaft descending into the well; yet more than a day was sometimes consumed before the gas could be drawn out by these means; and so abundant was at times the stream of gas discharged from the marl, that it would almost entirely extinguish the fire at the mouth of the shaft. Much time was thus lost, great expense incurred, and at times the life of the man endangered, for the gas would occasionally issue so rapidly, that it was impossible to draw him up sufficiently fast before he was greatly annoyed by it. It was therefore necessary to have recourse to another contrivance, which answered the purpose extremely well, occasioned no loss of time, was made at a small expense, and rendered the use of fire quite unnecessary. An oblong box of deal a foot square, was made open at the top, with a bottom to it, in the centre of which was a square hole, tightly fitted to an air-tight shaft, which projected down the well; a square flat piece of wood was exactly fitted to the internal surface of the box, but so as to slip easily up and down. It was split in the middle into two pieces, which were united by leather to act as a hinge, and to permit the two sides to flap up and down; hence it was denominated the flapper; to the centre of this flapper, between the two sides, was affixed a handle by which it was moved quickly up and down in the box, as in the act of churning. Thus the pure air of the atmosphere was churned or pumped down into the lower part of the well through the shaft,

and forced up the carbonic gas, its place being supplied by wholesome respirable air:—during the night when the deleterious gas had accumulated, a churning of a quarter of an hour or twenty minutes in the morning would effectually drive it out. During the day, whenever the man at work below felt hot and stifled from the approaching gas, he called out to the man above, who churned down some fresh air, which immediately cooled and relieved him, without the necessity of drawing him up. When I had ascertained the great utility of this *air-churn or lungs of the well,* I desired it might be occasionally worked, without waiting for the man calling from below. Had I been acquainted with this useful instrument when I first began to sink the well, it would have saved a great waste in time and firing, and I gladly take this opportunity of mentioning the circumstance, that others who engage in the same operation may avail themselves of it. It was amusing to observe the practical knowledge which the well-diggers possessed, without one spark of reasoning or philosophy; in this dilemma, when prevented from working by the carbonic gas, (or damp, as they called it,) they would at one time shower down finely-powdered lime into the well, and at another would send down buckets, and then upon drawing them up again, would turn them upside down on the earth, as if to empty them of some ponderous and visible substance. This, they said, would draw the damp from the well. The philosophical reader perfectly understands what all this means.

I also will not lose this public mode of giving another useful hint to those who may put down pumps at Tunbridge Wells, or in other places where carbonic acid gas abounds. When I found that not only the water of the well contained carbonic acid in a loose state of combination with oxide of iron, but that the gas issued in large quantities, uncombined and unneutralized, into the well from its sides, and that consequently after the pump was put down, and the well closed, it would be almost constantly filled with the carbonic gas, I was apprehensive that the lead commonly employed on these occasions, by being always immersed in moisture with an atmosphere of carbonic gas,

would be converted into a carbonate of lead, of which a small quantity is soluble in this water, and which, a direct poison, would be carried into the house, to the injury of the health of its inhabitants, who would of course be always taking it in their food. I therefore directed that cast-iron pipes should be substituted, which were accordingly put down in place of the lead, and whatever chalybeate impregnation might be given to the water from the cast-iron, would do no more harm than what was there already, and would moreover be easily got rid of by the means before suggested, which I fear would not be the case with the lead, a minute portion of which might possibly pass the strainer *dissolved* in the water; and in these opinions I am confirmed by you. I would therefore strongly recommend to all who put down pumps where carbonic gas abounds, and who value the health and lives of their families, to substitute cast-iron pipes for lead.

On the subject of the danger arising from lead, I may mention the very severe complaint which was produced by this noxious mineral some years ago at Tunbridge Wells. In the summer of the year 1815, several persons were severely afflicted with the lead colic; the late Dr. Mayo told me he had cases of the kind, and I have not the smallest doubt, from having witnessed the severity of this disease elsewhere, that those cases of colic which I saw came from the same deleterious source. In one lady, from Yorkshire, then resident at the Wells, the disease proceeded to such an extent, as to produce a paralytic affection of the lower extremities, a well-known effect of lead, of which, however, she afterwards happily recovered. In the summer of 1814, a man of the name of Taylor, a plumber at Tunbridge Wells, knowing the great inconvenience which people suffered from the want of a supply of good water, conceived and executed the laudable scheme of conveying it to the different houses, from a spring situated on an eminence, about a quarter of a mile from Tunbridge Wells. For this purpose he laid down 4000 feet of leaden pipes, which were soldered together every twelve feet. In the following year the lead colic occurred in those houses to which this water was distributed, and there appeared no doubt the poison came from the water, for it was

analyzed at my request by Dr. Lambe and Mr. Brande, and the lead detected; and I believe some other gentlemen, of known chemical abilities, also procured lead from the water, the greater part of which was in a state of suspension. It is an incidental confirmation of the fact, that the lady alluded to above was a water drinker, and partook largely of it. A serious alarm was, therefore, reasonably created at the time, but Mr. Taylor has substituted cast-iron pipes, and no complaint similar to the one which was so troublesome in 1815 has since made its appearance. I entertained an opinion, however, when the evil prevailed, that it might in time cure itself, for depositions from the water would probably coat the internal surface of the pipes, and defend it from the action of the water; some other circumstances also induced me to form this opinion, but the mischief which was in the mean time done to individuals, would not admit of delay, and I pressed upon Mr. Taylor the propriety of taking away the leaden pipes. The water at the fountain-head is perfectly good and pure, for that has been also analyzed Thus the minds of the residenters and visitors, who may live in those houses to which this water is distributed, may be quieted, but still it would, be prudent, on all accounts, to filter the water used for drinking.

I am, dear Sir,

Yours faithfully,

17, *Queen-street, May-Fair,* G. D. YEATS.
Dec. 11, 1822.

ART. XII. *An Investigation of the Methods used for approximating to the Roots of Affected Equations. By* Davies Gilbert, F.R.S., F.A.S., &c.; *in a Letter to the Editor of the* Quarterly Journal.

DEAR SIR,

IT is well known that several mathematicians have recently extended to Affected Equations, the method long in use for approximating to the root in cases where one power alone appears; each following a different line of induction, and originating his system independently of the others. The subject has

been treated very ably and generally by Mr. Horner, in the *Philosophical Transactions* for 1819: but as the following investigation appears to contain a more simple developement of the principle common to all the methods than has yet been given; and is, moreover, drawn out in the form most familiar to persons of this country; I request the favour of being allowed to insert it in your Journal.

Let $x^n + hx^{n-1} + ix^{n-2} + kx^{n-3} + lx^{n-4}$ &c. &c. $= N$ represent any equation with known coefficients extending to a given number of terms.

Assume r as nearly as possible to some one of the roots of the equation with N transposed.

And put $r + \varepsilon = x$ or the true root. Then

$$\left.\begin{aligned}
x^n &= r^n + nr^{n-1} \cdot \varepsilon + \frac{n \cdot \overline{n-1}}{1 \cdot 2} r^{n-2} \cdot \varepsilon^2 \\
&\quad + \frac{n \cdot \overline{n-1} \cdot \overline{n-2}}{1 \cdot 2 \cdot 3} r^{n-3} \varepsilon^3 \text{ \&c.} \\
hx^{n-1} &= hr^{n-1} + h \cdot \overline{n-1}\, r^{n-2} \cdot \varepsilon + h \cdot \frac{\overline{n-1} \cdot \overline{n-2}}{1 \cdot 2} r^{n-3} \cdot \varepsilon^2 \\
&\quad + h \frac{\overline{n-1} \cdot \overline{n-2} \cdot \overline{n-3}}{1 \cdot 2 \cdot 3} r^{n-4} \varepsilon^3 \text{ \&c.} \\
ix^{n-2} &= ir^{n-2} + i \cdot \overline{n-2}\, r^{n-3} \cdot \varepsilon + i \cdot \frac{\overline{n-2} \cdot \overline{n-3}}{1 \cdot 2} r^{n-4} \cdot \varepsilon^2 \\
&\quad + i \frac{\overline{n-2} \cdot \overline{n-3} \cdot \overline{n-4}}{1 \cdot 2 \cdot 3} r^{n-5} \varepsilon^3 \text{ \&c.} \\
kx^{n-3} &= kr^{n-3} + k \cdot \overline{n-3}\, r^{n-4} \cdot \varepsilon + k \frac{\overline{n-3} \cdot \overline{n-4}}{1 \cdot 2} r^{n-5} \cdot \varepsilon^2 \\
&\quad + k \frac{\overline{n-3} \cdot \overline{n-4} \cdot \overline{n-5}}{1 \cdot 2 \cdot 3} r^{n-6} \varepsilon^3 - \text{\&c.} \\
\text{\&c.} &= \text{\&c.} + \text{\&c.}
\end{aligned}\right\} = N$$

Here all the terms in the first column (which may be considered as coefficients of ε^0,) and all the coefficients of ε, of ε^2, of ε^3, &c., in the second, third, and following columns, are known quantities. Put then the coefficients of $\varepsilon^0 = A$, of $\varepsilon = B$, of $\varepsilon^2 = C$, &c. &c. And the equation will become

$$A + B\varepsilon + C\varepsilon^2 + D\varepsilon^3 + E\varepsilon^4, \text{ \&c.} = N.$$

Assume s an approximate value of ε; or as nearly as possible to the least root of this equation with N transposed.

And put $s + \eta = \varepsilon$ or the true root. Then

$$\left.\begin{array}{ll} A & = A \\ B\varepsilon & = Bs + B\eta \\ C\varepsilon^2 & = Cs^2 + 2Cs\eta + C\eta^2 \\ D\varepsilon^3 & = Ds^3 + 3Ds^2\eta + 3Ds\eta^2 + D\eta^3 \\ E\varepsilon^4 & = Es^4 + 4Es^3\eta + 6Es^2\eta^2 + 4Es\eta^3 + E\eta^4 \\ F\varepsilon^5 & = Fs^5 + 5\,Fs^4\eta + 10\,Fs^3\eta^2 + 10\,Fs^2\eta^3 + 5\,Fs\eta^4 + F\eta^5 \\ \&c. & \&c. \quad \&c. \quad 2 \quad 2 \quad 2 \quad 2 \end{array}\right\} = N$$

When as the horizontal ranks have the numerical coefficients of the binomial theorem to the indices 1, 2, 3, &c., the columns (as is well known) will have their numerical coefficients according to the orders of figurative numbers.

Let the coefficients of the first column (or of η^0) $= A_{,}$

Those of $\eta = B_{,}$; those of $\eta^2 = C_{,}$ &c.; then

$$A_{,} + B_{,}\eta + C_{,}\eta^2 + D_{,}\eta^3 + E_{,}\eta^4\ \&c. = N.$$

Now assume t an approximate value of η, as s was assumed to ε in the former case; then make $t + \xi = \eta$, or the true root; and by repeating the same steps

$$A_{,,} + B_{,,}\xi + C_{,,}\xi^2 + D_{,,}\xi^3 + E_{,,}\xi^4,\ \&c., = N, \text{ and so on.}$$

When the approximation has been carried to a sufficient degree of accuracy, or when the root has been strictly found, which will appear from the sum of all the terms involving ε or η or ξ, &c., becoming equal to nothing, (as indicated by A . $A_{,}$. $A_{,,}$ or $A_{,,,}$ &c., becoming equal to N,) x will be equal to $r + s + t$, &c.

It is obvious that although the different terms are connected by the sign plus (+) each coefficient may be either positive or negative, or equal to nothing, and that the assumed quantities r, s, t, &c., may be positive or negative in the same manner.

The methods best adapted for making the first approximation (r) are amply detailed in Maclaurin's *Algebra*, Part II. chap. 9, in Wood's *Algebra*, and in most elementary works.

The other approximations may be made by assuming $A + B\varepsilon$

$= N$, and consequently $s = \frac{N - A}{B}$ to be used for s, and more accurately by making $A + Bs + Cs^2 = N$, and resolving the quadratic. See Sir Isaac Newton's *Geometria Analetica*, cap. II.

Or if the equation rises to a great number of powers, four or five terms may be used; and the root, obtained by approximation on this less extensive scale, be made equal to s, as before.

For examples I would refer to,—Mr. Horner's paper, already cited from the *Philosophical Transactions* for 1819, page 308, and to a separate publication by Mr. Theophilus Holdred in the following year.

I remain,

&c, &c.

Art. XIII. *Proceedings of the Royal Society.*

Thursday, November 7, 1822. The Earl of Dartmouth, and George Townley, Esq., were elected Fellows of the Society.

A Paper was communicated by John Pond, Esq., Astronomer Royal, being an Appendix to a former Paper, on the Changes which appear to have taken place in the Declination of some of the Fixed Stars.

November 14. Lovell Edgeworth, Esq., Thomas Snodgrass, Esq., and Charles Augustus Tulk, Esq., were elected into the Society.

Mr. Pond's Paper was concluded, and he communicated another, on the Parallax of α *Lyræ*.

November 21. Rear-admiral Sir Edward Codrington, K.C.B., was elected a Fellow of the Society.

Charles Babbage, Esq., Sir Gilbert Blane, Bart., John Earl of Darnley, William H. Pepys, Esq., and Joseph Sabine, Esq., were elected Auditors of the Treasurers' Accounts on the part of the Society.

The Croonian Lecture was read by Francis Bauer, Esq. It contained an account of the Suspension of the Muscular Motion of the *Vibrio Tritici.*

Saturday, November 30, being St. Andrew's day, the Society held their anniversary meeting.

The Copley Medal was given to the Rev. William Buckland*.

The following were elected Members of the Council for the year ensuing:

1. *Members of the Old Council re-elected.*

Sir H. Davy, Bart.
W. T. Brande, Esq.
Samuel Goodenough, Lord Bishop of Carlisle.
Taylor Combe, Esq.
Davies Gilbert, Esq.
Charles Hatchett, Esq.
J. F. W. Herschell, Esq.
Sir E. Home, Bart.
John Pond, Esq.
W. H. Wollaston, M.D.
Thomas Young, M.D.

We are glad to learn that the propriety of regularly publishing these excellent discourses in the *Philosophical Transactions* has been suggested to the President, and we trust that he will accede to the suggestion, since it will in various ways contribute to the welfare of science in this country. They will furnish a gratifying record to those individuals who receive the medal; they will stimulate others to deserve such mark of distinction; and they will furnish the public with an elegant and succinct history of several branches of science.

It is to be regretted that the late Sir Joseph Banks's dissertations upon the same occasions have not been collected, revised, and published. They were clear, manly, and sensible compositions; his reading and information, which were very extensive, were always brought to bear with singular felicity, upon the subject before him, and we remember many of his addresses from the chair upon these occasions, which were much too luminous and instructive to be consigned to oblivion, among the unpublished archives of the Society. If the power of publishing Sir Joseph's discourses be, as we presume it is, vested in the Council of the Royal Society we trust that it will be acted upon.

2. Members of the Society, chosen into the Council.

Charles Babbage, Esq.
Sir Gilbert Blane, Bart.
Charles Lord Colchester.
J. W. Croker, Esq.
John Earl of Darnley.
Sir H. Halford, Bart.
Charles Hutton, L.L.D.
Captain H. Kater.
W. H. Pepys, Esq.
Joseph Sabine, Esq.

Officers for the ensuing Year.

PRESIDENT.—Sir H. Davy, Bart.

TREASURER.—Davies Gilbert, Esq., M.P.

SECRETARIES.—William Thomas Brande, Esq.
Taylor Combe, Esq.

Thursday, December 5. The Right Hon. Robert Peel, Captain R. Z. Mudge, and Sir John Fenton Boughey, Bart., were elected into the Society.

The reading of the Croonian Lecture was resumed and concluded.

Thursday, December 12. A Paper was communicated by Dr. Wollaston, on Metallic Titanium. A Paper was also communicated by Sir E. Home, on the Structure of the Membrana Tympani and Internal Ear of the Elephant.

Thursday, December 19. Dr. Daubeny was elected into the Society.

A Paper on the Chinese Year, by J. F. Davis, Esq., F.R.S., was read.

Art. XIV. ANALYSIS OF SCIENTIFIC BOOKS.

I. *Pharmacologia; comprehending the art of prescribing upon fixed and scientific Principles, together with the History of medicinal Substances.* By J. A. Paris, M.D., F.R.S., &c. 2 vols. 8vo., 25*s.* boards. 5th edition.

This is a very entertaining, and, in some respects, instructive work; we shall, therefore, endeavour to draw an outline of its contents for the amusement and information of our general readers, recommending the perusal of the book itself to the medical profession.

The motley assemblage of substances which, at different times, have been admitted into the Materia Medica, the absurdity of some, the disgusting and loathsome nature of others, their questionable activity and fluctuating reputation, are circumstances which naturally excite us to inquire how it is that articles once highly esteemed should have sunk into disrepute; that others of doubtful efficacy should have maintained their ground; and on what account materials of no energy whatever, have received the sanction of the wisest practitioners of different ages and times. "Physic," says a foreign writer, "is the art of amusing the patient, while nature cures the disease," and a glance at the heterogeneous absurdities of the Materia Medica would induce us to acquiese in this sarcasm, were it not that a cool and dispassionate inquiry into the revolutions that have occurred in the opinions of mankind with respect to the curative powers of medicinal agents, furnishes materials, which, in a great measure, calm our apprehensions, and remove our prejudices.

In reverting to the history of the Materia Medica, we shall, it is true, be struck with the inequality of its progress towards its present advanced state, as compared with other branches of scientific inquiry; but we must remember how peculiarly exposed it is to superstition, caprice, and knavery, and how rarely those methods of research applicable to the mathematical and physical sciences, can be applied in the investigation of remedies, for every problem which involves the phenomena of life is embarrassed by such complicated circumstances as to set at defiance all ordinary means of appreciating their influence.

We are lost in conjecture and fable in attempting to fix the period when remedies were first employed for the alleviation of bodily suffering. In the most remote times, in the rudest states of society, and amidst uncultivated and savage tribes, medicine was cherished as a blessing, and practised as an art; the regulation and change of diet, and of habit, must have intui-

tively suggested themselves for the relief of pain; and when such resources failed, charms and incantations were resorted to.

Our author observes that Dr. Warburton is evidently wrong in assigning the origin of amulets to the age of the Ptolomies, (300 years before Christ), since Galen tells us that Nechepsus, 630 years before the Christian era, recommended a green jasper cut into the form of a dragon, and applied externally to the stomach, to strengthen digestion. Again, what were the ear-rings which Jacob buried under the oak of Shechem but amulets? Nor were such means confined to barbarous ages. Theophrastus pronounced Pericles to be insane because he wore a charm; and Caracalla, in the declining era of the Roman empire, issued an edict ordaining that no one should wear superstitious amulets.

In the progress of civilization various incidents in the choice and preparation of aliments must have unfolded the remedial powers of many natural substances; these were recorded, and the authentic history of medicine may date its commencement from the period when such records began. In the temple of Esculapius, in Greece, diseases and cures were registered upon marble tablets; and the priests prepared the remedies and directed their application, and thus began the profession of physic. The earliest records show that the ancients possessed many powerful remedies. Melampus administered steel wine and hellebore; Podalirius practised venesection; the *nepenthe* of Homer, if not opium, was some analogous sedative prepared from the poppy. The sedative powers of the lettuce were also known in the earliest times, for we read that after the death of Adonis, Venus lulled her grief by reposing upon a bed of lettuces. Under the mystic title of the *Eye of Typhon*, the Egyptians administered squills in the cure of dropsy; and cataplasms are also of extreme antiquity, for Nestor applied a mixture of cheese, onion, flour, and wine, to the wounds of Machaon.

"The revolutions and vicissitudes" says Dr. Paris, "which remedies have undergone in medical as well as popular opinion from the ignorance of some ages, the learning of others, the superstitions of the weak, and the designs of the crafty, afford ample subject for philosophical reflection." From his lengthy account of these revolutions we shall endeavour to select the most prominent facts.

Lord Bacon has justly observed that, "in the opinion of the ignorant multitude, witches and impostors have always held a competition with physicians," and this competition, we are sorry to add, as far as impostors are concerned, has extended to our own time. Superstition, under its various aspects, has always predominated in physic, partly in consequence of obscurity in the nature of disease and the art of its removal, and partly

because disease awakens fear. Hence it is that the wrath of heaven, the resentment of demons, and the malignant aspect of the stars, have been resorted to as the sources of disease; and hence the introduction of remedies intended rather as expiations at the shrines of offended spirits, than as natural medicinal agents: thus precious stones, at first used as amulets, were afterwards powdered and swallowed. Sennertus speaks of a dry tench as an amulet for the cure of jaundice; afterwards, tench broth got into fashion for the same disorder.

A propensity to attribute natural effects to unnatural causes, is also one of the striking peculiarities of medical superstition. Soranus, instead of referring the use of honey in the cure of the thrush in children, to its bland medical qualities, attributes it to the bees having hived near the tomb of Hippocrates; and herbs were imagined to acquire distinct virtues according to the planet under whose ascendency they were collected. The character ℞, which physicians at this day place at the head of their prescriptions with the meaning of *Recipe*, is a corruption of the astronomical symbol of Jupiter. Aperients were administered at particular stages of the moon, or at certain planetary conjunctions; and the practice of bleeding "at spring and fall," so long observed in this country, owed its existence to the same belief.

It is curious that medical superstition has never been confined to the prejudiced and vulgar, but has extended its influence over the best informed and instructed minds; Cicero and Aurelius, Bacon and Boyle, were equally open to its delusions; and in our own times the patients of Miss Prescott, the advocates of the metallic tractors, and the admirers of Mr. Whitlaw, may be adduced as analogous specimens.

To superstition and credulity we must add scepticism as a third enemy to the progress of rational medicine, and one, which naturally enough, has acquired great sway; it has chiefly arisen from the exorbitant and encomiastic praises which have been heaped upon different remedies at different times, and which having disappointed expectation, have wholly, but undeservedly, fallen into entire discredit. "The inflated eulogiums," says Dr. Paris, "bestowed upon the operation of *digitalis* in pulmonary diseases, excited, for some time, a very unfair impression against its use; and the injudicious manner in which the antisiphylitic powers of nitric acid have been aggrandized, had very nearly exploded a valuable auxiliary from modern practice." Hemlock, too, lies open to the same remark. When its use was revived by Dr. Stoerck, of Vienna, it was announced as a cure for all manner of incurable diseases and discordant maladies, and when its virtues were found inadequate to these expectations, it was rejected as inert and useless. Cubebs and

colchicum, now in their glory, are probably destined to share the same fate.

In observing upon the influence of false theories and absurd conceits upon the progress of the Materia Medica, our author takes a cursory view of some of the principal hypotheses which have prevailed in medicine, and which have conferred an ephemeral popularity upon crowds of inert and insignificant drugs. The school of Galen, for instance, taught that all medicines possessed one of the *cardinal* virtues of heat, cold, moisture, or dryness: diseases were similarly subdivided, and were to be treated by the opposite remedies. The four greater, and four less, hot and cold seeds, are upon this principle still maintained in some foreign Pharmacopœiæ; and in the London Dispensatory of 1721, we find the powders of hot and cold precious stones, and the hot and cold compound powder of pearls.

The methodic sect, founded by Themison, referred diseases to overbracing, and to relaxation, and adopted a corresponding classification of remedies; a theory long banished from the schools, but still exerting its influence in practice. They observed that parchment was alternately rendered flabby and crisp by hot and cold water, and thence the notion of the relaxing and strengthening influence of the hot and cold bath upon the living fibre.

The Stahlians, trusting to the *Spiritus Archæus*, or *Vis Medicatrix naturæ*, put but little faith in any extraneous remedies, but they were vigilant and acute observers of the progress of disease. The Mechanical Theory ascribed diseases to lentor and viscidity of the blood; hence the doctrines of *obstructions*, with their corresponding classes of remedies; while the Chemists, on the other hand, explained all morbid phænomena by a reference to acid and alcaline predominance.

But no medical hypothesis has conferred reputation upon inert substances, to the same extent as the *Doctrine of Signatures*, which assumes that "every natural substance which possesses any medicinal virtue, indicates, by an obvious and well marked external character, the disease for which it is a remedy, or the objects for which it should be employed." Paracelsus, Baptista Porta, and Crollius, were renowned advocates of this speculation. Thus the *lapis ætites*, which is a hollow pebble containing another loose and rattling within it, was considered as effectually preventing abortion when worn upon the arm, and as promoting delivery when fixed upon the thigh. The lungs of a fox were regarded as a cure for asthma, because that animal is remarkable for strong powers of respiration. Turmeric is yellow, and therefore good for the jaundice. Poppies have *heads*, and hence their influence upon that part of the body. Upon the same principle the long pods of the *cassia fistula* must

relieve diseases of the intestines, and the hard seeds of the gromwell alleviate calculous disorders. Eyebright acquired fame in complaints of the eye from the black spot upon its corolla; and the blood-stone from its red specks was deemed efficacious in hæmorrhage from the nose.

Under the head of "devotion to authority and established routine," Dr. Paris very justly animadverts upon the absurdities of the French Pharmacopœia, which still cherishes many of the pharmaceutical monsters of former days in all their original deformity, and of which we have given some account in a former number.

The same devotion to authority (observes our author) which induces us to retain an accustomed remedy with pertinacity will always oppose the introduction of a novel practice with asperity, unless, indeed, it be supported by authority of still greater weight and consideration. The history of various articles of diet and medicine, will prove, in a striking manner, how greatly their reputation and fate have depended upon authority. It was not until many years after ipecacuan had been imported into Europe, that Helvetius, under the patronage of Louis XIV., succeeded in introducing it into practice; and to the eulogy of Katherine, Queen of Charles II., we are indebted for the general introduction of tea into England.

The history of the potato is equally extraordinary; its introduction was opposed by the vulgar for more than two centuries, until Louis XV. wore a bunch of its flowers upon a gala day at court. The history of the warm bath, of Peruvian bark, and of tobacco, are also adverted to by Dr. Paris, as affording analogous instances of the influence of devotion to authority in effecting the introduction and use of articles of the Materia Medica.

Fashion, however, has not confined her interference to the selection of remedies, but has also decided upon the nature of diseases. Queen Anne was subject to hypochondriacal attacks, which her physicians called the *spleen*, and recommended pearl cordial for its cure. The spleen and the cordial were thus rendered fashionable complaints and remedies. After Dr. Whytt's publication on nervous diseases, no lady of fashion was troubled with the spleen, but now became *nervous*; and this term has lately yielded to *bilious*, and to the fashionable practice among certain medical men of pummelling their patients in the region of the liver, till they persuade them that they feel a tenderness there.

Under the head of "assigning to art that which is the effect of unassisted nature, or the consequence of incidental changes of habit, diet, &c." Dr. Paris offers further specimens of the delusions to which his profession is especially open. His remarks on *Watering Places* are particularly amusing.

The Chemist (he says) will tell us that the springs of Hampstead and Islington rival those of Tunbridge and Malvern; that the waters of Bagnigge Wells, as a chalybeate purgative, might supersede those of Cheltenham and Scarborough; and that an invalid would frequent the spring in the vicinity of the Dog and Duck in St. George's Fields with as much ad

vantage as the celebrated Spa at Leamington. The Physician, however, well knows that it is the journey, the change of scene and habits, the varieties of pursuit and amusement, that are the real remedies of our watering-places: and that, on the other hand, the recommendation of change of air and habits will rarely inspire confidence, unless apparently associated with medical treatment.

How our Physicians, who migrate in the summer and autumn to the bathing and watering-places, will like the home truths which Dr. Paris so candidly expounds, we know not; but it has always appeared to us that their presence is highly necessary, not to direct the dose of the water, or the number of ablutions, but to obviate the mischief which continually arises from sea bathing improperly indulged in, and from drenching the stomach, and weakening its powers, by large draughts of dilute saline solutions.

Under the head "Ambiguity of Nomenclature," Dr. Paris has collected some good instances of the mistakes that have occurred from the same name having been at different periods applied to different substances; and it is not uncommon to find a word originally used to express general characters, subsequently become the name of a specific substance in which such characters are predominant. The term "Αρσενικον," from which the word *arsenic* is derived, was originally applied to all poisonous minerals, and arsenic being especially powerful, it became, in process of time, limited to *orpiment*, the most commonly occurring compound of that metal. The term *verbena*, our author tells us, originally denoted all those herbs that were held sacred as being employed in the rites of sacrifice; but as *one* herb was usually adopted on those occasions, the word *verbena* came to denote that particular herb only. *Vitriol*, originally denoting any crystalline substance, was afterwards limited to particular salts. Opium, which in its primitive sense signifies *juice*, (from οπος, *succus*,) is now limited to one species, that of the poppy. Towards the conclusion of this article of his historical introduction, Dr. Paris touches, too lightly we think, upon the mischief that has arisen, and that is likely to arise, from the introduction of modern chemical nomenclature into the Materia Medica and Pharmacy. We shall not digress into any remarks upon the merits or demerits of that nomenclature as employed by chemical writers, but we are happy in this opportunity of expressing our decided opinion against its adoption in the Pharmacopœiæ issued by the College of Physicians, and this for several reasons. In the first place, it is not to be expected that physicians, in full practice, should have leisure, even if they had inclination, to follow the progress of chemical discovery, and the consequent fluctuations of chemical theory with their correspondent changes of nomenclature. In the next place, essential as a knowledge of chemistry is to the medical student, and zealous as many of those students are in its acqui-

sition, there are more who enter into practice very imperfectly initiated even in the rudiments of that science, and quite unacquainted with the facts and theories which lead to the modification of the terms employed in abstract chemistry. And, lastly, admitting the Physician, the Student, the Apothecary, and his assistants and apprentices, to be perfect in the doctrines and nomenclature of chemistry, the terms thence derived are, from their complexity and length, quite unsuited to the brevity and perspicuity required in the prescription of the Physician. Consequently, where chemical nomenclature has been adopted to its full extent, as in the French *Codex*, it becomes preposterously extravagant and absurd; and where only partially employed, as in the London Pharmacopœiæ, it involves erroneous terms, and enforces misconception. What can be more absurd than the term *Sub-deuto-carbonas potassii* of the Codex; or more erroneous than that of *Hydrargyri Submurias*, as applied by the London College? Why not rest content with *Kali* and *Calomel?*

In Dr. Paris's section "On the application and misapplication of Chemical Science," he has interwoven some very just remarks respecting the connexion of Chemistry and Pharmacy, and has given a concise abstract of Chemico-pharmaceutical history. There are, however, parts of this section which we had hoped would have been omitted in the present edition, and to which we refrain from offering reply or observation; not that we are alarmed by our author's assertions, nor silenced by what he is pleased to term "the animated but cool and candid defence of the late Professor of Chemistry in the University of Oxford," nor satisfied with the evidence which he adduces in favour of his own University, nor convinced of the chemical perfection of the late Pharmacopœia; but because we are certain the observations which have excited our author's angry animosity were neither written in the spirit, nor published with the intention, which he is pleased, in a paragraph at page 99 of the book we are reviewing, to assign to them.

That substances may occasionally be chemically inconsistent, but medically compatible, and, *vice versâ*, is a position of our author which we are willing to admit in its utmost extent, and cordially join with him in deprecating the too prevalent and fashionable absurdity of attempting to account for the phœnomena of life upon principles deduced from the analogies of inert matter. Upon this subject we cannot do better than quote the late Dr. William Hunter, who saw the mischief of these delusive but tempting theories, and who adverted to them in his lectures with his usual judgment and facetiousness. "Gentlemen," said he, "Physiologists will have it that the stomach is a mill; others, that it is a fermenting vat; others, again, that it is a stew-pan: but, in my view of the matter, it is neither a mill,

a fermenting vat, nor a stew-pan, but it is a stomach, Gentlemen, a stomach." This anecdote we take from Sir Gilbert Blane's "Medical Logic;" a work from which we have derived much pleasing information; and which we are happy in this opportunity of recommending, not merely to the attentive perusal of the junior branches of the profession, but to all who are interested in medical literature.

After some remarks on the influence of culture and climate upon the energies of medicinal plants, upon the adulteration of medicines, and upon the unseasonable collection of vegetable remedies, Dr. Paris concludes his "Historical Introduction," with a section "on the obscurity which has attended the operation of compound medicines." It is, of course, difficult, and often impossible, to ascertain to which ingredient of a very compound remedy the effects produced ought to be attributed; and it has frequently happened that inert and frivolous substances have thus gained a share of credit exclusively due to their associates. The chemical agencies of bodies must here also be taken into the account; for among mineral substances especially, active remedies may thus become inert, and inactive substances may give rise to the formation of very active and formidable compounds.

In the second division of his first volume, Dr. Paris proceeds to a review of the operations of medicinal bodies, and of the classifications founded on them. He defines medicinal substances to be "those bodies which by due administration are capable of producing certain changes in the condition of the living system, whereby its morbid actions may be entirely removed, or advantageously controlled." The arrangement of these substances which our author adopts is that of the late Dr. Murray, of Edinburgh, as set forth in his "System of Materia Medica, and Pharmacy;" and in his observations upon them we perceive nothing sufficiently original or important to require particular notice; we, therefore, pass on to the third and last of these preliminary essays, "on the theory and art of prescribing."

The importance of mixing and combining medical substances, and the increased efficacy which is thus often conferred upon them, was known to, and appreciated by, the physicians of remote ages; and lately the theory of these combinations, and the best, safest, and surest, modes of effecting them, have been diligently investigated, and form a prominent feature in the prescriptions of the pharmacopœia, and in the extemporaneous recipes of medical practitioners. Dr. Paris, therefore, somewhat surprises us when he talks of this inquiry as an unexplored field of research. Its high importance, and the carelessness with which it is usually pursued by hospital pupils, justify the space and attention given to it in the work before us, but we doubt whether the experienced practitioner will derive

any new light from this bulky subdivision of the Pharmacologia. Thus, we see nothing new in the suggestion of combining tincture with decoction of bark, and of adding the powder, or extract, as occasion may require; nor in combining different narcotics, antispasmodics, and bitters, with a view of obtaining a more agreeable or effectual remedy than could be derived from any single substance. Every nurse is aware that salts and senna operate more effectually than either ingredient singly taken; and one grain of emetic tartar, with twenty of ipecacuan, is a common family emetic. But although there is a good deal of tautology in this portion of Dr. Paris's book, we repeat that the student should attentively peruse it, because it will, in many places, direct his attention to the *object* of several combinations which experience has suggested and sanctioned, and point out to him the cause of many apparent anomalies in the practice of our best physicians.

Speaking of change of diet and habits, Dr. Paris warns the young practitioner not to exercise his *caduceus* as Sancho's Doctor did his wand. In these respects the prejudices of the sick should not be wantonly or harshly opposed. With regard to diet, no function of the body is so materially influenced by mental impressions as *digestion*. The unexpected communication of any distressing event destroys the keenest appetite, and converts hunger into disgust for food: this fact did not escape Shakspeare, who represents Henry VIII. dismissing Wolsey with these words,—

> Read over this;
> And after, this; and then to breakfast
> *With what appetite* you have.

"If," says our author, "feelings of disgust are excited by the repast, the stomach will never act with healthy energy on the ingesta; and in cases of extreme aversion, they are either returned, or they pass through the alimentary canal almost unchanged. On the other hand, the gratification which attends a favourite meal, is, in itself, a specific stimulus to the organs of digestion, especially in weak and debilitated habits." This, it must be admitted, is very comfortable doctrine. Dr. Paris further illustrates it by a facetious story aptly communicated to him by Dr. Merriman, of a lady of rank, whose state of stomach was so unrelenting that all food and medicine was rejected: after the failure of the usual remedies, she applied to Miss Prescott, and was magnetized; when, to the astonishment of every one, she ate a beefsteak, and continued to repeat the meal every day for six weeks, without the least inconvenience!

But the diet of the valetudinarian is too important a matter to be trifled with, and its due management often requires more skill upon the part of the physician than that of medicinal remedies. How many are the diseases which may be traced to im-

proper quantity or quality of food; and how grievous are the sufferings which may be ascribed to excess of nutriment among the higher classes of society, more especially of those resident in London, who live full and high, without that proportion of air, exercise, and employment, which is requisite to its due elaboration. How many bilious and nervous disorders, as our doctors call them, are thus excited or generated, and how much bodily and mental suffering might be spared by temperance in eating. In our days, the degrading fashion of hard-drinking has certainly declined, and a corresponding improvement in health and morals has been the consequence. We have but few tipplers left, and they are deservedly excluded from all decent society. But *hard-eating* has unfortunately gained a proportionate ascendency, and the appetite is artificially stimulated and excited by a thousand mischievous combinations unknown to our ancestors, and infinitely seductive and hurtful. The roast beef of Old England has ceded its wholesome dominion to a host of French *entremets* and *hors d'œuvres*, and with them a series of disorders have become prevalent, quite as grievous as those which our forefathers derived from the bottle: in short, gluttony has succeeded inebriety; and although the *connoisseurs* and *bon vivants*, the mouthicians and palaticians of Dr. Kitchener, may be shocked at the term, they are neither more nor less than downright gluttons, and but a shade better than the drunkard. It is not, however, to one, or even two good dishes, that we object, but to the system of an almost indefinite succession of stimuli. The stomach, distended with soup, is next tempted with all manner of fish, flesh, and fowl; the vegetable world is ransacked from the *cryptogamia*, upwards; and to this miscellaneous aggregate are superadded the pernicious pasticcios of the pastry-cook, and the complex combinations of the confectioner. All these evils, and many more, have those who move in *good* society to cope with; and it is with this variety of temptation, with this series of successive stimulants, that the stomach, good-natured and accommodating viscus as it is, has to contend. We repeat, that it is not to one or two good things, even abundantly indulged in, that we object; but to the system of overloading the stomach: nine persons in ten eat as much soup and fish as would amply suffice for a meal, and as far as soup and fish are concerned, would rise from their dinner satisfied, and even saturated. A new stimulus appears in the form of stewed beef, or *coutelettes à la suprême*—then comes a Bayonne, or Westphalia ham, or a pickled tongue, or some analogous salted but proportionately indigestible dish, and of each of these enough for a single meal, is super-added to the burthen under which the stomach is already groaning: but this is not all—game follows, and to this succeed the sweets, and that most indigestible of all coagula, cheese, associated, per-

haps, with some saline stimulus in the form of an anchovy or caviar: the whole is crowned with a variety of flatulent fruits, and indigestible knick-knacks, included under the term *dessert.* Wine we have purposely omitted. Thus, then, it is that the stomach is made (with many of us daily *during the season*) to receive not one full meal, but is actually distended with a succession of meals rapidly following each other, and vying in their miscellaneous and pernicious nature, with the ingredients of Macbeth's caldron. The epicure talks of the easy digestion and light nature of turtle and venison, and of the quantity which can be eaten of either of those dishes; but the fact is, that at such a feast little else is generally superadded, and the digestion of a full feed of any *single* material is easy work for the stomach, compared with the miscellaneous drudgery which it is usually called upon to perform.

We have digressed a little upon the subject of over-eating, because we are convinced that it is the bane of life, and that it requires, in both sexes, more of the physician's attentive consideration than it generally receives. It is an ungracious task to curb the appetite of the sensualist, and restrain the voracity of the glutton; but it is one which the doctor, who does his duty, often ought to perform, instead of tampering with the epicurean propensities of his patient by the administration of rhubarb and bitters. It is true that there are constitutions which endure over-eating with impunity, just as there are drunkards who have lived to eighty; and that those persons who, to strong digestive powers, add regular hours, and above all, exercise, may often continue to overload the stomach with little other disadvantage than ordinary dyspeptic symptoms. But the studious and sedentary are the principal sufferers, and they seldom discover their danger till it is past removal; they are assailed by head-aches and hypochondriasis—by plethora and palpitations—by vertigo, constipation, nausea, and want of sleep; the physician tells them that they are *bilious*, and, perhaps, quells the most pressing symptoms by antispasmodics and evacuants, or flatters them by the assurance that they are suffering under the *disorders of genius*, as Dr. Stuart has lately called these maladies; whereas the *cure* is to be found in air, exercise, and a *plain diet*, physic being at the same time "thrown to the dogs." Truly does the poet observe,

> The first physicians by debauch were made;
> Excess began and sloth sustains the trade.
> Better to hunt in fields for health unbought,
> Than fee the doctor for a nauseous draught.
> The wise for cure on exercise depend,
> God never made his work for man to mend.

Dr. Paris's just observations on diet, induce us to regret that he has not taken a more general and extended view of its in-

fluence upon mental and bodily health; his brevity is our apology for the preceding digression, and our end will be attained should it lead his attention to the subject.

To revert, with our author, to the *diet of the sick;* it should never combine too much nutriment in too small a space, "lest *fermentation,* instead of *digestion,*" says Dr. Paris, "should ensue:" a position, this, in which we do not exactly coincide; for a sick person's stomach will often only endure very small quantities of very condensed nutriment, and of that "a little and often," is generally no bad maxim. Sir William Temple's notion, however, "that the stomach of a valetudinarian is like a school-boy, always doing mischief when unemployed," errs upon the other side; for the healthy conversion of aliment into blood is incompatible with the unceasing activity of the stomach: periods of rest are required; for when in health, we loathe food during that important part of the digestive process in which chyle is forming and absorbing, and if it be taken, it does infinite mischief; whereas, increase of appetite during this stage of assimilation is symptomatic of disease, as we see in certain mesenteric affections, and in diabetes. These views, Dr. Paris tells us, have induced him to treat those affections in a different manner from that generally pursued; his plan consists in enforcing longer intervals between each meal, which should be scanty, and in quantity short of what the appetite may require:

> In this way the unwilling absorbents are induced to perform their duties; but it is a practice which, from the extreme anxiety of friends and relations, the feelings of craving and hunger expressed by the patient, and the mistaken but universal prejudice respecting diet, it is always painful to propose, and generally impossible to enforce; where, however, circumstances have given me full control, the advantage of the plan has been most decisive. Vol. I. p. 273.

To these remarks, succeed a variety of useful observations upon the general management of remedies, upon the advantages derived from particular mixtures and combinations, and upon the most agreeable and efficacious forms of prescription, in which *simplicity* is, as far as possible, very properly inculcated. We have often been struck with the complexity of a physician's prescription, and have been quite unable to guess at his object and intention in assembling a phalanx of apparently discordant, and often inert, articles of the Materia Medica. Dr. Paris has helped us out of this difficulty. I was once told, he says, by a practitioner in the country, that the quantity, or rather complexity, of the medicines which he gave his patients, for there never was any deficiency in the former, was always increased in a ratio with the obscurity of their cases; "if," said he, "I fire a great profusion of shot, it is very extraordinary if some do not hit the mark." Sir Gilbert Blane has related as good a story.*

* Medical Logic. Edit. 2, p. 192.

"A practitioner being asked by his patient why he put so many ingredients into his prescription, is said to have answered more facetiously than philosophically, "*in order that the disease may take which it likes best.*" A patient in the hands of such a doctor reminds our author of the Chinese Mandarin, who, upon being taken sick, sends for twelve physicians, and swallows, in one mixture, all the potions which each separately prescribes. The young practitioner, however, should be reminded that unless the mutual actions of bodies upon each other, and upon the living system, is thoroughly understood, *in proportion as he complicates a medicine, he does but multiply the chances of its failure.*

In describing the errors which may be committed in the composition or directions of a prescription, Dr. Paris suggests several useful precautions, and dwells more especially upon the necessity of chemical knowledge. "The file of every apothecary," he says, "would furnish a volume of instances where the ingredients of the prescription are fighting together in the dark, or at least are so adverse to each other as to constitute a most incongruous and chaotic mass."

> "Obstabat aliis aliud: quia corpore in uno
> Frigida pugnabant calidis, humentia siccis,
> Mollia cum duris, sine pondere habentia pondus."
>
> *Ovid. Met.* lib. i. 19.

In adjusting the doses of his remedies, experience must be the practitioner's chief, and often only, guide. The tyro is apt to suppose that the power of a remedy increases with its dose, whereas the dose often determines its specific action. The preparations of antimony vomit, purge, or sweat, according to the quantity exhibited; and opium, in large and small doses, generally produces diametrically opposite effects. It often may be remarked that large doses produce a *local*, while small doses produce a *general*, effect; whence it is, perhaps, probable that medicinal, like nutritive substances, are more readily absorbed into the circulating system, when presented in small than in large quantities. A large quantity of food, taken seldom, does not fatten so much as smaller quantities at shorter intervals, as is shewn in the good condition of cooks and their assistants, who are perpetually sipping, but seldom feasting: butchers, too, are rarely great eaters, but they get fat by the slow but sure process of absorption by the surface. Our author thinks that it is not pressing the principle of analogy too far, to suppose that the action of *alteratives*, which require to be absorbed, may be more effectually answered by similar management, that is, by exhibiting small doses at short intervals.

In apportioning the dose of medicines, certain general circumstances, which influence their operation, must not be lost

sight of; among these the diminution of power induced by the protracted use of a medicine, and the relative degrees of power between the system and the remedy, are important. How much the activity of opium is influenced by habit, is too well known to require more than mere mention. And again, when a patient has been exhausted by protracted and severe suffering, a dose differing from one at the commencement of the disease will, probably, be requisite. The *variable* activity of a medicine should also be appreciated, and the practitioner should cautiously feel his way when employing active but uncertain remedies: foxglove is particularly in need of this caution.

The time of day at which remedies should be administered also deserves attention, especially where the quiet and comfort of the patient are essentially concerned: in fevers, for instance, purgatives should be so timed as to operate in the day, in order that the quiet of the night may not be infringed upon; and emetics, in similar cases, should be exhibited in the evening, because they induce a tendency to sleep and perspiration, which it is useful to promote.

Lastly, constitutional peculiarities, or *idiosyncrasies*, should always be borne in mind. There are habits in which opium produces no rest, but great excitement; in which a small dose of calomel is followed by obstinate salivation; in which a single grain of James's powder is succeeded by vomiting and repeated faintings; and we remember the case of a woman who was seized with sickness and tenderness of the bowels, and for whom an emetic, a purge, and a blister, were prescribed; the latter produced gangrenous erysipelas, and she sank under constant vomiting and a diarrhœa which could not be checked.

The conclusion of this volume treats "of the particular forms of remedies, and the general principles upon which their construction and administration are to be regulated."

In speaking of *powders*, we think Dr. Paris incorrect when he says that the impalpable form is injurious to cinchona, rhubarb and guaiacum, in consequence, of an essential part of their substance being chemically changed by the operation. Had such an opinion come from *us*, our author would have called us *ultra-Chemists.*

The suggestions respecting the changes in form and composition which some substances suffer on mixture and trituration, should be carefully perused by the practitioner: the liquefaction of dry salts, under these circumstances, is not unfrequent; and the physician, by inattention to such circumstances, "will be often betrayed into the most ridiculous blunders; an instance of which very lately came to my knowledge in a prescription for the relief of cardialgia and constipation in the case of dyspepsia; it directed *sulphate of soda and carbonate of potass*, in the form of a powder, but the *fiat* of the physician upon this occasion

only served to excite the ridicule of the dispenser, who soon discovered that the ingredients in his mortar dissolved into a liquid." We can furnish Dr. Paris with a converse instance in the case of the *syrup of senna* of the late Pharmacopœia, which concreted into a solid, and, to the surprise of the physician, was sent to his patient in a pill-box.

When powders are of difficult solubility, we must guard against their intestinal accumulation, by maintaining during their use, a regular alvine evacuation. Instances are on record, in which powdered bark and magnesia have been thus suffered to accumulate. Bread adulterated with the impalpable felspar of Cornwall, and biscuits containing plaster of Paris, have created similar inconvenience. Sugar-plums are often similarly compounded, and children's bowels are so impatient of insoluble and extraneous contents, that, in respect to them, extreme precaution in these respects is necessary. We cordially join with Dr. Paris, in reprobating the practice lately suggested of improving bad flour by the addition of magnesia. "I object," he says, "to the introduction of any foreign and insoluble substance into our daily bread; and I am satisfied that the result of medical experience will sanction such an objection." Vol. i. p. 332.

Pills, and their peculiarities, are next treated of, and we trust that the suggestions here thrown out will not be wasted upon the compilers of the forthcoming *Pharmacopœia*, for it appears to us quite obvious that few *pill masses* should be there retained; they are apt to become either too soft or too hard by keeping; and in the latter case, we often see a hot spatula thrust into the pot for the removal of a portion of its indurated contents, and a hot pestle applied to render the mass tractable. To many *extracts* the same objection more forcibly applies, in consequence of the direction in the *Pharmacopœia*, that they should be "evaporated until they have acquired a consistence proper for making pills." The extracts of bark, sarsaparilla, and white poppy, and the compound extract of colocynth, are particularly open to these remarks. Perhaps the best way of getting over the difficulty, would be to desiccate them in all cases in a water-bath, until they admit of being powdered; by which, uniformity in their activity and convenience in their employment, would be most effectually attained. The ingredients for pills might also be kept in a pulverulent state, and rendered into a mass when used.

This volume concludes with a collection of formulæ, intended to illustrate its precepts, and to furnish the inexperienced prescriber with a series of useful and instructive lessons; these we have carefully perused, and find them judiciously composed and selected, but the system of *key letters*, which seems to be a hobby with Dr. Paris, we cannot applaud; few

students, we are convinced, will be at the pains of deciphering the intention of the different ingredients by their aid, and we are certain that none who have attentively read the author's previous instructions, will require it.

The second volume of the *Pharmacologia* is devoted to an alphabetical list of the articles of the *Materia Medica* with a condensed account of their properties and uses; it contains a great deal of useful information in a small space, but we regret that, under the head *Chemical Composition*, Dr. Paris has not spoken more at length of the theory of the Pharmacopœia processes; if he had briefly explained these, he would have added much to the value of his work, as far as the student is concerned, and have contributed no unacceptable information to the majority of his professional brethren. The space which we have devoted to the first volume forbids our entering into the details of the second, more especially as they are principally of an abstract and purely practical nature; we shall, however, for the amusement and information of our readers, select from it a few of the *recipes* for celebrated quack medicines, the principal of which Dr. Paris has been at the pains of examining, and has boldly published the formulæ for their preparation.

Anderson's Pills.—Aloes, jalap, oil of aniseed.

Aromatic Lozenges of Steel.—Sulphate of iron, and tincture of cantharides!

Pectoral Balsam of Honey.—Tincture of benzoin!

Barclay's Antibilious Pills.—Extract of colocynth, 2 drachms, extract of jalap, 1 drachm; almond soap, 1 drachm and a half; guaiacum, 3 drachms; tartarized antimony, 8 grains; essential oils of juniper, caraway, and rosemary, of each 4 drops, formed into a mass with syrup of buckthorn, and divided into 64 pills.

Bates's Anodyne Balsam.—1 part of tincture of opium, 2 parts of opodeldoc.

Black Drop.—Take half a pound of opium sliced, three pints of good verjuice, 1 ounce and a half of nutmegs, and half an ounce of saffron; boil them to a proper thickness, then add a quarter of a pound of sugar, and two spoonfuls of yeast; set the whole in a warm place near the fire for six or eight weeks, then place it in the open air until it becomes a syrup; lastly, decant, filter, and bottle it up. One drop is considered equal to three of the tincture of opium of the pharmacopœia.

Brodum's Nervous Cordial consists of the tinctures of gentian, calumba, cardamom, and bark, with the compound spirit of lavender and wine of iron.

Chelsea Pensioner, a cure for rheumatism.—Powdered guaiacum, 1 dr.; rhubarb, 2 drachms; cream of tartar, 1 ounce; flowers of sulphur, 2 oz; 1 nutmeg finely powdered; make into an electuary, with one pound of clarified honey; two large spoonfuls to be taken night and morning.

Ching's Worm Lozenges.—Chiefly calomel and jalap.

Colley's Depilatory.—Quicklime and sulphuret of potass. (We suspect orpiment in this compound.)

Daffy's Elixir.—Compound tincture of senna of the Edinburgh Pharmacopœia, sweetened with treacle, and flavoured with aniseed and elecampane root. *Dicey's Daffy, and Swinton's Daffy* differ little from each other.

Dalby's Carminative.—Magnesia, 40 grains; oil of peppermint, 1 drop; of nutmeg, 2 drops; of aniseed, 3 drops; tincture of castor, 30 drops; of assafœtida, 15 drops; of opium, 5 drops; spirit of pennyroyal, 15 drops; compound tincture of cardamoms, 30 drops; peppermint-water, 2 ounces.

Essence of Coltsfoot.—This preparation (says Dr. Paris), consists of equal parts of the balsam of Tolu, and the compound tincture of benzoin, to which is added double the quantity of rectified spirit of wine; and this, forsooth,

is a *pectoral for coughs!* If a patient, with a pulmonary affection, should recover during the use of such a remedy, I should certainly designate it as a lucky escape, rather than a skilful cure.

Whitehead's Essence of Mustard.—Oil of turpentine, camphor, and spirit of rosemary, with a little flour of mustard to colour it.

Freeman's Bathing Spirits.—Opodeldoc, coloured with Daffy's elixir!

Godbold's Vegetable Balsam.—Honey and vinegar!

Gowland's Lotion.—A solution of corrosive sublimate, in emulsion of bitter almonds.

James's Analeptic Pills.—James's powder, gum ammoniacum, pill of aloes, with myrrh, of each equal parts, made into a mass with tincture of castor.

Norris's Drops.—A coloured solution of tartarized antimony in rectified spirit.

Remedies for the Hooping-cough.—Either opiates or medicines containing sulphate of zinc.

Roche's Embrocation for the Hooping-cough.—Olive oil, mixed with half its quantity of the oils of cloves and amber.

Ruspini's Tincture for the Teeth.—Florentine iris root, 8 ounces; cloves, 1 ounce; rectified spirit, 2 pints; ambergris, 1 scruple.

Scouring Drops.—Oil of turpentine, perfumed with essential oil of lemon-peel.

Solomon's Balm of Gilead.—An aromatic tincture, of which cardamoms form the leading ingredient, made with brandy. Some practitioners have asserted that cantharides enter its composition.

Steer's Opodeldoc.—Castile soap, 1 ounce; rectified spirit, 8 ounces; camphor, 3 ounces and a half; oil of rosemary, half a drachm; oil of origanum, 1 drachm; solution of ammonia, 6 drachms.

Taylor's Remedy for Deafness.—Garlic, infused in oil of almonds, and coloured by alcanet root.

Here we must take leave of Dr. Paris, with many thanks for the amusement and information afforded us by his book; its materials have evidently been collected with much pains and diligence, and they are put together with skill, and generally with candour. Though at variance with him upon a few points, we sincerely wish him the success he merits in the pursuit of his truly liberal and honourable profession; a profession which, in this country, is characterized, not merely by the learning and knowledge of its leading members, but by their unaffected philanthropy, unostentatious charity, and upright zeal.—FLOREAT.

II. *Philosophical Transactions of the Royal Society of London, for the year* MDCCCXXII. PART II.

WE resume the account of the contents of this volume, from page 172 of our last Number. The present part of the *Philosophical Transactions* is eminent for the number and excellent execution of its copper-plate prints, which are twenty in number, and though not upon subjects particularly novel or important, are not the less creditable to the draughtsman and the engraver. We propose, as usual, to give a condensed abstract of each of the papers, extending it in proportion to their originality and interest.

1. *Experiments and Observations on the Developement of Magnetical Properties in Steel and Iron, by Percussion. By* William Scoresby, jun., esq.

Since the publication of Oersted's *Discovery*, the magneticians have been singularly on the alert, and a great deal has been written upon the subject, much of which is new and curious, and much also trifling and unimportant. The production of magnetism by percussion was discovered by Dr. Gilbert in the 16th century, but its laws and phenomena not having been accurately investigated, Mr. Scoresby was induced to institute a series of experiments, to determine them with more precision, and some of his results deserve attention.

When a bar of *soft-steel*, six inches and a half long, and a quarter of an inch diameter, held vertically, and resting upon freestone, was struck 17 blows with a hammer *, it acquired the power of lifting 6½ grains ? 22 blows did not augment the force.

When the bar rested vertically upon a parlour poker (previously deprived of magnetism), 42 blows gave it the power of lifting 88 grains, and 90 blows, with a larger hammer, augmented the lifting power to 130 grains. The poker was also rendered magnetic. Farther hammering rather diminished than increased the power. On inverting the bar, a single blow nearly destroyed the magnetism; two blows changed the poles. Hammering the bar in the plane of the magnetic equator, also destroyed the polarity. The magnetism by percussion was augmented when the length of the bars was increased.

Thus a quarter-inch cylindrical bar of steel, five inches long, after receiving 20 smart blows, produced a deflection of the needle, at the distance of three inches, of 13°, and lifted 6½ grains. Another piece of the same bar, 7½ inches long, after similar treatment, produced a deviation of 21°, and lifted 45 grs.; and a third bar of the same kind, 12 inches long, after twenty similar blows, occasioned a deviation of the compass of 33°, and easily lifted 88 grains. The shortest bar, it was observed, received the full effect by the two first blows; but the others continued to increase in energy as the percussion was continued. These bars did not receive a power equal to that first used; the cause was probably their greater hardness.

The strong magnetizing effect of percussion on soft steel, induced Mr. Scoresby to apply the property to the formation of magnets:

For this purpose I procured 2 bars of soft steel, 30 inches long and an inch broad; also six other flat bars of soft steel, 8 inches long and half an inch broad, and a large bar of soft iron. The large steel and iron bars were not however absolutely necessary, as common pokers answer the purpose very well; but I was desirous to accelerate the process by the use of substances capable of aiding the developement of the magnetical properties in steel. The large iron bar was first hammered in a vertical position. It was then laid on the ground, with its acquired south pole towards the south, and upon this end of it the large steel bars were rested while they

* We do not think it necessary to specify the weight of the hammer used, as it had no regular effect upon the magnetism excited, and as the blows having been struck by the hand must have varied much in intensity.

were hammered; they were also hammered upon each other. On the summit of one of the large steel bars, each of the small bars, held also vertically, was hammered in succession, and in a few minutes they had all acquired considerable lifting powers. Two of the smaller bars, connected by two short pieces of soft iron in the form of a parallelogram, were now rubbed with the other four bars in the manner of Canton. These were then changed for two others, and these again for the last two. After treating each pair of bars in this way for a number of times, and changing them whenever the manipulations had been continued for about a minute, the whole of the bars were at length found to be magnetized to saturation? each pair readily lifting above eight ounces!

We should like to hear of the repetition of these curious experiments, since, in our hands, they have by no means succeeded to the extent announced by the author, probably from some inattention to minutiæ, which he has not sufficiently explained in his paper.

2. *On the Alloys of Steel. By* J. Stodart, Esq., and Mr. M. Faraday, Chemical Assistant in the Royal Institution.

This paper contains an extension of the experiments detailed in a former communication, and an account of the manufacture of the alloys upon a large scale, which the authors were enabled to accomplish, chiefly through the liberality of Dr. Wollaston, who also gave them his valuable advice and assistance.

The first curious fact that occurs relates to the compound with silver, of which steel will only retain one 500th part in union; when more was used, it either evaporated, or separated as the button cooled, or was forced out in forging. The alloy was excellent, and the trifling addition of price furnishes no obstacle to its general employment.

Steel, alloyed with 100dth part of platinum, though not so hard as the silver alloy, has more toughness; hence its value, where tenacity, as well as hardness are required: the extra cost is more than repaid by its excellence.

The alloy with rhodium exceeds the former in its valuable qualities, but the scarcity of the metal precludes its general use. To the compounds with iridium and osmium the same remarks apply.

The action of acids on these alloys is curious, and especially in respect to that of platinum, which is acted upon by dilute sulphuric acid with infinitely greater rapidity than the unalloyed steel; indeed, an acid that scarcely touches the pure steel, dissolves the alloy with energetic effervescence. This is no doubt referable to electrical excitation, and we should apprehend that it would be fatal to the employment of this particular alloy, in any case where chemical action is likely to ensue.

The alloys of steel with gold, tin, copper, and chromium, we have not attempted in the large way. In the laboratory, steel and gold were combined in various proportions; none of the results were so promising as the alloys already named, nor did either tin or copper, as far as we could

judge, at all improve steel. With titanium we failed, owing to the imperfection of crucibles. In one instance, in which the fused button gave a fine damask surface, we were disposed to attribute the appearance to the presence of titanium; but in this we were mistaken. The fact was, we had unintentionally made wootz. The button, by analysis, gave a little silex and alumine, but not an atom of titanium; menachanite, in a particular state of preparation, was used; this might possibly contain the earths or their basis, or they may have formed a part of the crucible.

Our authors advert to the probable importance of certain triple, alloys only one of which is noticed in their paper, namely, that of steel, iridium, and osmium. "Some attempts toform other combinations of this description proved encouraging, but we were prevented at the time from bestowing on them that attention and labour they seemed so well to deserve."

The following is an important and curious paragraph of this paper:

When pure iron is substituted for steel, the alloys so formed are much less subject to oxidation. 3 per cent. of iridium and osmium, fused with some pure iron, gave a button, which, when forged and polished, was exposed, with many other pieces of iron, steel, and alloys, to a moist atmosphere; it was the last of all showing any rust. The colour of this compound was distinctly blue; it had the property of becoming harder when heated to redness, and quenched in a cold fluid. On observing this steel-like character, we suspected the presence of carbon; none, however, was found, although carefully looked for. It is not improbable that there may be other bodies, besides charcoal, capable of giving to iron the properties of steel; and though we cannot agree with M. Boussingault*, when he would replace carbon in steel by silica, or its base, we think his experiments very interesting on this point, which is worthy farther examination.

In conclusion, our authors observe, that to succeed in making these compounds, much attention is requisite on the part of the operators; that the purity of the metals is essential; that the perfect and complete fusion of both must be ensured; that they must be kept a considerable time in a state of thin fusion; that after casting, the forging is with equal care to be attended to; that the metal must on no account be over-heated; and that the hardening and tempering must be most carefully performed.

Upon the whole, though we consider these researches upon the alloys of steel as very interesting, we are not sanguine as to their important influence upon the improvement of the manufacture of cutlery, and suspect that a bar of the best ordinary steel, selected with precaution, and most carefully forged, wrought, and tempered, *under the immediate inspection of the master*, would afford cutting instruments as perfect and excellent as those composed of wootz, or of the alloys.

3. *Some Observations on the Buffy Coat of the Blood.* By John Davy, M.D., F.R.S.

The peculiar appearance which the blood occasionally assumes in certain inflammatory diseases, and which it some-

* *Annales de Chimie*, xvi. 1.

times also exhibits where there is no inflammation at all, has been supposed by some to depend upon its unhealthy thinness, or increased tenuity, and, by others, has been referred to its slow coagulation. In either case, a portion of the spontaneously coagulating albumen is left free from colouring matter, in the form of a crust or coat, of a yellowish or buff colour. Dr. Davy observes, that in some diseases the blood coagulates quite as rapidly as in a state of health, and yet exhibits the buffy coat; this, therefore, is in favour of diminished viscidity. He observes, however, that in inflammatory diseases the specific gravity of the blood is not lowered, and therefore that Mr. Hey's notion of the coagulable lymph being in these cases attenuated by an extra-proportion of serum, is probably incorrect.

In the second section of his paper, Dr. Davy has a few remarks upon those morbid adhesions of serous membranes which ought to play smoothly upon each other; and inquires how far the age of such adhesions may be inferred from their strength. It is a received opinion, that weak adhesions are recent, but that when firm, they are of long standing. The object of our author's remarks semes to be, to prove that no opinion of the ages of adhesions can be correctly founded upon their appearance when examined after death, and he advances the following arguments on this head: 1. That wounds are often firmly united in twenty-four hours. 2. That upon injecting brandy through a wound of the chest in a dog, between the lungs and pleura, and killing the said dog twenty-four hours afterwards, firm and long adhesions were found. 3. He observes, that

> The coagulated lymph of the buffy coat of the blood may be used as an illustration and confirmation of the short time in which strong adhesions may form. Liquid, when the blood is drawn, coagulable lymph gradually becomes, first viscid, and afterwards solid. In the viscid state, as I have frequently observed, when it is still transparent, it has the tenacity of mucus, and admits of being drawn out into fibres and bands, which, soon becoming solid and opaque, very well represent the ordinary adhesions of the lungs; and in a very few hours attain their maximum of strength. This viscidity, which coagulable lymph acquires in passing from a liquid to a solid form, has not, that I am aware, been noticed by authors; and the formation of adhesions is usually explained without reference to this quality *.

In the last division of his paper, Dr. Davy inquires into the probability that the fluid found after death in the cavities of serous membranes may have been poured out subsequent to the cessation of life. To determine this point, three dogs were submitted to the following operation. In each instance,

> The animal was suddenly killed by a blow on the occiput; the cavity of the chest was instantly laid open, and the pericardium inspected. A small

* Vide *The Morbid Anatomy of some of the most important Parts of the Human Body*, by Matthew Baillie, M.D., F.R.S., &c. 5th edit., p. 6.

quantity of serum was found in it, which was removed with a sponge, and the incisions made were closed by sutures. At the end of twenty-four hours the sutures were divided, and the pericardium was again examined. Not a single drop of fluid had collected in it, in any instance, though in two of the trials the right auricle and ventricle were considerably distended with blood.

The author applies these results to man, and remarks that no inference can be drawn from serous effusions having produced no observed effects during life, since large portions of fluid have been found in the pericardium, and even in the ventricles of the brain, without a single symptom to indicate the fact.

4. *On the Mechanism of the Spine. By* Henry Earle, Esq. F.R.S.

This paper describes the peculiar mechanism of the spine and spinal canal in birds, by which a remarkable extent of motion is obtained in the neck without pressure on the medullary column. It is curious, that the cervical vertebræ in birds are not only numerous, but that they vary in number from nine to twenty-four; whereas, in the class *mammalia*, their number, with one exception (the three-toed sloth), is constantly *seven*. The mole, whose head appears buried between the shoulders, has precisely the same number as the horse, and as the preposterously long-necked giraffe.

Mr. Earle's is a curious paper, but as a great part of it consists of explanations and descriptions of complicated processes and tuberosities not intelligible without his accompanying plate, we must refer our anatomical readers to the original for these details of structure. His observations upon the mechanism and uses of the human spine are well put together, and deserve the attention of those who are fond of detecting what they call *contrivance* in the works of nature; that is, of comparing the works of Infinite Wisdom, whence all our *contrivances* have originated, with what they blindly refer to the effort of human sagacity and invention. Our author's pathological hints at the conclusion of his paper also merit notice:

That a certain degree of freedom of motion between the membranes is essential to the due performance of the functions of the spinal marrow, is proved by the effect of accidents and disease. It would be out of place here, to bring forward a detail of particular cases, but I may mention briefly, that I have ascertained, by dissection, that the most distressing train of nervous symptoms, and even complete paraplegia, may be produced by adhesions taking place between the membranes, and by effusion into the canal or theca.

In conclusion I may observe, that this view of the subject tends to throw considerable light on the pathology of the spine, and assists in explaining a circumstance which I have repeatedly noticed in diseases affecting the vertebræ, namely, that the symptoms of irritation and inflammation of the spinal marrow are much more early manifested, and are generally far more serious in their consequences when the dorsal vertebræ are affected, than when either the cervical or lumbar are the seat of disease. In the former case, the slightest congestion or effusion is often productive of serious symptoms, from the canal being smaller and more completely filled with the marrow and its membranes; whilst, in the latter description of

cases, from the greater capacity of the canal and looseness of the membranes, considerable effusion may exist, without, at first, producing any marked symptoms, more particularly in the lumbar region, where other circumstances concur in rendering the effect of pressure less sensibly felt; to enter into a description of which would be foreign to the object of this paper.

5. *Of the Nerves which associate the Muscles of the Chest in the Actions of Breathing, Speaking, and Expression; being a Continuation of the Paper on the Structure and Functions of the Nerves. By* Charles Bell, Esq.

In this paper, Mr. Bell proceeds on the principle assumed in his former communication—that the intricacies of the nervous system in man depend on superadded nerves, and that through these, certain parts, which in the lower animals have simple uses, acquire additional functions.

He shews, that when the act of respiration belongs to the constitution of an animal, new nerves, having a distinct centre or source of power, are superimposed, without deranging the original simple and symmetrical system which is common to every creature that has feeling and motion.

He proceeds to shew, that when the act of respiration is performed by ribs alternately rising and falling, the muscles brought into action are very numerous, and the nerves which combine and control the motions of the numerous and distinct muscles are proportionably extensive.

He explains, in the next place, how the organs of respiration in man are made subject to many functions, and that hence the human system of respiratory nerves is more complicated than that of any other animal. Thus, for example, it is shewn, that when respiration is made subservient to speaking, singing, and expression, or to the mere acts of coughing, sneezing, and spitting, there is necessarily a combination of very distant parts with the simple or original act of moving the thorax, and that to establish these relations, new or additional nerves are added.

Mr. Bell then exhibits these respiratory nerves diverging from a centre, and shews, by experiments, that the division of any one of them cuts off the parts respectively from conforming to the act of respiration; and moreover, that the injury of the centre or origin of these nerves deprives a person of life in a manner so rapid, that the agony of dying is not perceptible when life is thus extinguished.

After proving the importance of these nerves to respiration, and consequently to life, the attention of physicians is directed to the consideration of the state of this system of nerves in all cases of sudden death, when there is no apparent or great disorder of the brain or heart.

The last part of the paper is a short developement of the effect of emotion on the heart, and the reflected influence of

the heart on the muscles of expression, through the agency of these respiratory nerves. The following are some of Mr. Bell's remarks upon this subject:—

It would have been extraordinary, if we had arrived at any satisfactory theory of expression, before it was known through what instruments the mind influenced the body during emotion or passion. But since we know that the division of the respiratory nerve of the face deprives an animal of all expression, and that the expressive smile of the human face is lost by an injury of this nerve; since it is equally apparent, that the convulsions of laughter arise from an influence extended over this class of nerves; it comes to be in some sort a duty, in pursuing this matter, to examine farther into the subject of expression. We may at the same time be assured of this, that whatever serves to explain the constant and natural operations of the frame, will also exhibit to us the symptoms of disease with more precision. In terror, we readily conceive why a man stands with eyes intently fixed on the object of his fears, the eye-brows elevated, and the eye-balls largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this we only perceive the intent application of his mind to the objects of his apprehensions, and its direct influence on the outward organs. But when we observe him farther, there is a spasm in his breast; he cannot breathe freely; the chest remains elevated, and his respiration is short and rapid: there is a gasping and convulsive motion of his lips, a tremor on his hollow cheeks, a gulping and catching of his throat; his heart knocks at his ribs, while yet there is no force in the circulation, the lips and cheeks being ashy pale. It is obvious there is a reflected influence in operation. The language and sentiment of every people have pointed to the heart as the seat of passion, and every individual must have felt its truth. For though the heart be not in the proper sense the seat of passion, it is influenced by the conditions of the mind, and from thence its influence is extended through the respiratory organs, so as to mount to the throat and lips and cheeks, and account for every movement in passion, which is not explained by the direct influence of the mind upon the features.

So we shall find, if we attend to the expression of grief, that the same phenomena are presented, and we may catalogue them, as it were, anatomically. Imagine the overwhelming influence of grief: the object in the mind has absorbed the powers of the frame; the body is no more regarded, the spirits have left it; it reclines, and the limbs gravitate, the whole body is nerveless and relaxed, and the person scarcely breathes; so far there is no difficulty in comprehending the effect in the cause. But why, at intervals, is there a long-drawn sigh; why are the neck and throat convulsed; and whence the quivering and swelling of the lips? why the deadly paleness, and the surface earthy cold; or why does convulsion spread over the frame like a paroxysm of suffocation?

This system of nerves, extricated from the seeming confusion in which it lay hitherto encumbered, is found to be superadded to that of mere feeling and agency—attributes common to all animals. Through it, we see, ingrafted, as it were, and superadded to the original nature, higher powers of agency, corresponding to our condition of mental superiority. These are not the organs of breathing merely, but of natural and articulate language also, and adapted to the expression of sentiment, in the workings of the countenance and of the breast, that is by signs as well as by words. So that the breast becomes the organ of the passions, and bears the same relation to the developement of sentiments, as the organs of the senses do to the ideas of sense.

6. *Experiments and Observations on the Newry Pitchstone, and its Products: and on the formation of Pumice. By* the Right Hon. George Knox, F.R.S.

This paper contains one position to which we cannot assent, namely, that the above-mentioned pitchstone contains *nicotine*,

a peculiar substance which, upon the authority of Vauquelin, exists in, and confers its peculiarities upon, *tobacco.* When this pitch-stone is distilled *per se*, a small quantity of a peculiar bituminous matter which it contains, and which the author proposes to call *Newrine*, is separated, probably in an altered state, appearing as an oily fluid, smelling exactly like a "tobacco-pipe long in use." The residue in the retort was a pale ash-gray, porous, semi-vitrified substance, exactly resembling pumice. The artificial formation of a substance, having, as our author proves, all the properties, even the magnetic property of volcanic pumice, is an interesting circumstance, and may throw some light upon the natural formation of that body. Mr. Knox adds the following interesting observations:

It appears to be a condition, in converting a stone into pumice, that it should contain a volatile substance, which can only be removed by the same degree of heat which is at the same time necessary for producing that sort of semi-vitrification in the mass which renders it coherent, hard, and porous. If a stone contains only water, pumice is not formed, because that is driven off by a red heat, which does not act upon the earths of which the stone is composed. Drive off the water at a red heat, and you have a harder but incoherent mass; increase the heat, and you have, as in the case of alumine, a more compact and denser substance, or else, when the ingredients of the stone favour vitrification, a glass.

There are many valuable remarks connected with chemical analysis scattered through this communication, but Mr. K. appears to have fallen into some errors in his determination of the quantity of soda contained in pitchstone; we, at least, cannot follow him in his conclusions. The Newry pitchstone is characterized by its large proportion of bitumen, a peculiar oily smell, a tendency to divide into thin laminæ, and disintegrate spontaneously into rhomboidal fragments. Mr. Knox gives the following as its components:

Silica	72.800
Alumine . . .	11.500
Lime	1.120
Protoxide of iron . .	3.036
Soda	2.857 ?
Water and bitumen .	8.500
	99.813

7. *Observations on the Changes the Egg undergoes, during Incubation in the common Fowl, illustrated by Microscopical Drawings. By* Sir E. Home, Bt., V.P.R.S.

Among the numerous obligations under which science lies to the author of this paper, there is none for which we feel more grateful than having enlisted Mr. Bauer into the service of animal physiology. We by no means intend to underrate the importance of that gentleman's contributions, to botanical science, but we sincerely believe that, without Sir Everard

Home's zealous and earnest interposition, his labours would have been confined to that less interesting and useful branch of human knowledge. With the exception, perhaps, of Mr. Clift, whose accuracy and rigid adherence to nature and to truth can never be too highly estimated, Mr. Bauer has shewn himself, under the auspices of our author, the most correct and able anatomical draughtsman in Europe, while the dexterity and skill with which he uses the microscope, confer a peculiar character and unrivalled value upon many of his graphical contributions. The engravings annexed to this paper, were they the only produce of Mr. Bauer's pencil, would amply justify the above remarks; they are not only executed with infinite taste and delicacy, but when minutely compared and examined, they carry with them entire conviction as to their accuracy, and conformity to nature, qualities which the works of Mr. Bauer's microscopical predecessors very rarely possess. Sir Everard's paper consists in a minute detail of the phenomena of the incubation of the egg, every statement that is advanced being verified by reference to the annexed drawings, so that any abstract, without such aid, would scarcely be intelligible. It is a curious contribution, and fills a gap which has long existed in this department of physiology.

8. *Some Observations on Corrosive Sublimate.* *By* John Davy, M.D., F.R.S.

The object of this communication is to rectify some erroneous statements which have prevailed in chemical and pharmaceutical writers, respecting the solubility and other chemical habitudes of corrosive sublimate. It is shown that light slowly decomposes the aqueous solution of corrosive sublimate, as also the *liquor hydrargyri oxymuriatis* of the Pharmacopœia; but that the solutions in alcohol and in ether, and those in water acidulated by muriatic acid, or containing a little muriate of ammonia, are not thus affected. That water at 57° dissolves about 5.4 per cent; alcohol at 60°, 50 per cent., and ether about 33 per cent of this substance. That corrosive sublimate, and the volatile and fixed oils, mutually decompose each other. That muriatic acid, sp. gr. 1.158, at 74°, dissolves twice its weight, forming a solution of a sp. gr. =2.412, which suddenly solidifies when cooled a little, but again liquefies in the warm hand. That it is insoluble in concentrated nitric and sulphuric acids, even at the temperature of 90°. That muriate of ammonia and corrosive sublimate unite, and form double salts. That a saturated solution of muriate of ammonia, at 60°, dissolves its own weight of corrosive sublimate. That a saturated solution of common salt, composed of 20 grains of water and 7 of salt, dissolve 32 grains of corrosive sublimate, at 60°.

These observations are valuable to the pharmaceutical chemist. We wish Dr. Davy would extend his inquiries to the influence of various agents upon emetic tartar, for the *liquor antimonii tartarizati* of the Pharmacopœia, and several other solutions of that useful antimonial are prone to a decomposition, in which oxide of antimony is precipitated.

9. *On the State of Water and Aëriform Matter in Cavities found in certain Crystals.* *By* Sir H. Davy, Bt., P.R.S.

It is assumed by geologists that much of the surface of our present globe must have once been in a fluid state, but different schools have assumed different causes as productive of this effect, some referring to aqueous, others to igneous, liquefaction.

I have often (says Sir H. Davy,) in the course of my chemical researches, looked for facts or experiments, which might throw some light on this interesting subject, but without success, till about three years ago, when, in considering the state of the fluid and aëriform matters included in certain crystals, it appeared to me that these curious phenomena might be examined in a manner to afford some important arguments as to the causes of the formation of the crystal.

Sir Humphry then goes on to reason upon the state of the water contained in these crystals, which, if enclosed in them at a pressure and temperature not very unlike those of our existing atmosphere, ought to fill nearly the same space as when included; if, on the contrary, it took place at a higher temperature, a certain vacuum might be expected in the cavity, from the contraction of the fluid, and if any air or gas were present, a considerable rarefaction of it. Upon examining several crystals containing cavities with included water, and not permeable to the atmosphere, the cavities were found to contain a more or less perfect vacuum; the aëriform matter was azote, and the water was *nearly pure*, appearing only to have absorbed the chief part of the oxygen of the originally included atmosphere. It appears from these researches, that the existence of water in crystalline rocks is adverse to the Neptunian theory, which it has always been considered to justify. In an appendix, Sir Humphry describes the existence of a liquid resembling naphtha, in a crystal from the magnificent collection of C. H. Turner, Esq. He also describes an experiment upon a crystal in the collection of the Royal Institution, showing that in its cavities, which were very minute, the air, instead of, as in all the former cases, being rarefied, was compressed, so as to enlarge to 10 or 12 times its original volume, upon drilling into the vesicles containing it.

10. *Some Experiments on the Changes which take place in the Fixed Principles of the Egg, during Incubation.* *By* William Prout, M.D., F.R.S.

These experiments (says the author,) demonstrate, or render probable, the following circumstances:—

1. That the relative weights of the constituent principles of different eggs vary very considerably.

2. That an egg loses about one-sixth of its weight during incubation, a quantity amounting to eight times as much as it loses in the same time under ordinary circumstances.

3. That in the earlier stages of incubation, an interchange of principles takes place between the yelk and a portion of the albumen; that this interchange is confined on the part of the yelk to a little of its oily matter, which is found mixed with the above-mentioned albumen; that this portion of albumen undergoes some remarkable changes, and is converted into a substance analogous in its appearance, as well as in some of its properties, to the curd of milk; and, lastly, that a portion of the watery and saline portion of the albumen is found mixed with the yelk, which becomes thus apparently increased in size.

4. That as incubation proceeds, the saline and watery parts again quit the yelk, which is thus reduced to its original bulk; that in the last week of the process it undergoes still further diminution in weight, and loses the greater portion of its phosphorus, which is found in the animal converted into phosphoric acid, and in union with *lime*, constituting its *bony skeleton*; and lastly, that this lime does not originally exist in the recent egg, but is derived from some unknown source during the process of incubation.

11. *On the Placenta.* *By* Sir E. Hone, Bt., V.P.R.S.

The observations contained in this paper are preparatory to a new classification of animals, founded upon the difference in the structure of the Placenta. Of this classification a specimen is offered by the author, illustrated by 7 plates, from Mr. Clift's drawings.

12. *Of the Geographical Situation of the three Presidencies, Calcutta, Madras, and Bombay, in the East Indies.* *By* J. Goldingham, Esq., F.R.S.

13. *Of the Difference of Longitudes found by Chronometer, and by Correspondent Eclipses of the Satellites of Jupiter; with some Supplementary Information relative to Madras, Bombay, and Canton; as also the Latitude and Longitude of Point de Galle and the Friar's Hood.* *By* J. Goldingham, Esq., F.R.S.

It is impossible to abridge the voluminous details of these papers; we shall, therefore, merely give the results of the author's observations, which appear to have been conducted with the utmost patience and accuracy.

	°	′	″	
Longitude of the Madras Observatory, East of Greenwich	80	17	21	
Latitude of ditto	13	4	9.1	N.
Longitude of Fort William	88	23	39	E.
Latitude of ditto	22	33		N.
Longitude of Bombay Lighthouse	72	53	36	E.
Latitude of ditto	18	54	25	N.

	°	′	″	
Longitude of Point de Galle Flagstaff .	80	17	2	E.
Latitude of ditto	6	0	50	N.
Longitude of the Friar's Hood . . .	81	36	3¼	E.
Latitude of ditto	7	29	35	N.
Longitude of Canton	113	17	39	E.

14. *Observations on the Genus Planaria.* *By* J. R. Johnson, M.D., F.R.S.

This paper describes the habits of several species of the above singular and extensive genus. The planariæ are little animals, found in slow streams, usually clustered together, and attached to the roots and leaves of aquatic plants, or to pieces of wood, &c. When at rest, they appear spherical; when in motion, linear; they move sometimes like the snail, and sometimes like the leech. Their anatomy is with difficulty made out, but the body appears to consist of one common cavity, with diverging cells, like that of the medicinal leech. They have two circular ventral apertures, the lower one conducting to the ovarium; the uppermost giving passage to a long flexible tube, the use of which Dr. Johnson discovered by accident. Being desirous of ascertaining their proper food, he threw among them several aquatic insects and worms; presently one of them projected his tube, and firmly affixed it to the worm; other planariæ now came to his assistance, and all the writhings of the worm were inadequate to his disentanglement. They seized upon dead worms in the same way, and while thus affixed, their heads and mouths appeared unoccupied, which induced our author to suspect that they might receive nourishment by the tube. To determine this point, he cut the head off one of the planariæ, and a day or two after the headless body affixed itself by the tube to a worm, and became as before, distended with food, thus affording indisputable proof of nourishment having been taken by the tubular organ only. When, however, this tubular organ is injured, or removed, they then take sustenance by the mouth.

Dr. Johnson has ascertained that some of the species of planariæ are oviparous; these animals have, however, another method of perpetuating their species, namely, by a *natural* division of the body into two portions, the head part reproducing a tail, and the tail a head, in about fourteen or more days, depending upon the state of the atmosphere. The author details a number of experiments, illustrating this reproduction after artificial division. To render these successful, the planariæ should be divided immediately on being taken from their native haunts, for confinement renders them sickly and inactive.

15. *Some Experiments and Researches on the Saline Contents of Sea Water, undertaken with a view to correct and improve its Chemical Analysis. By* Alexander Marcet, M.D., F.R.S.

Rouelle and Proust both suspected the existence, or occasional existence, of mercury, or of some mercurial salt, in sea-water, but no sample examined by Dr. Marcet was found to afford the slightest trace or suspicion of that metal. Nitric salts have been suspected in sea-water, but our author found none; to determine this point, he used the following process suggested by Dr. Wollaston: The bittern was concentrated in a retort, till it began to deposit solid matter; sulphuric acid and gold leaf were then added, and the mixture was boiled; the gold-leaf was not in the least acted upon, nor was any smell of nitric acid perceived; but on adding the smallest quantity of nitric acid to the same mixture, the gold was dissolved, and the smell of *aqua regia* was instantly perceived. No muriate of lime could be detected in sea-water, but it was found to contain carbonate of lime, muriate of ammonia, and triple sulphate of magnesia and potash.

16. *On the Ultimate Analysis of Vegetable and Animal Substances. By* Andrew Ure, M.D., F.R.S.

This paper treats of one of the most abstruse and intricate departments of chemical science, that of determining the relative proportions of the ultimate elements of organic bodies, and we have no hesitation in pronouncing it the best essay which has hitherto appeared upon this very complicated subject. Yet we must confess that we always enter upon details, such as are contained in Dr. Ure's communication, with feelings of doubt and scepticism, partly from practical experience of the apparently insurmountable difficulties which inherently belong to the investigation; partly from the discordance in the results of our most eminent and dexterous experimenters; and partly from the temptations which the atomic doctrine here peculiarly holds out to swerve into the regions of theory and hypothesis. We are at the same time willing to allow, that we feel infinitely more satisfied with Dr. Ure's details, and more inclined to repose with confidence upon his results, than those of any of his predecessors in this branch of analysis; and this because his details are more minute, his methods better devised, his repetition of experiments more frequent, and his attachment to speculation less glaring than theirs.

Our author sets out with some valuable remarks relating to the materials employed, and more especially upon the hygrometric quality of oxide of copper, and upon the mode of bringing the various organic objects of research to a state of thorough and uniform desiccation; he then, aided by an annexed

plate, describes the apparatus and materials which he employed, and the various steps of his mode of operating; he next gives in detail an example of the mode of computing the relation of the constituents from the experimental results, which together with his "Table of Organic Analysis," we shall transcribe for the information of our readers.

1.4 grains of sulphuric ether, specific gravity 0.70, being slowly passed in vapour from the glass bulb through 200 grs. of ignited peroxide of copper, yielded 6.8 cubic inches of carbonic acid gas at 66° F., which are equivalent to 6.57128 of dry gas at 60°. This number being multiplied by 0.127= the carbon in 1 cubic inch of the gas, the product 0.8345256, is the carbon in 1.4 grains of ether; and $0.8345256 \times \frac{8}{3} = 2.2254 =$ the oxygen equivalent to the carbonic acid. The tube was found to have lost 4.78 grs. in weight, 0.1 of which was due to the hygrometric moisture in the oxide, and 1.4 to the ether. The remainder, 3.28 is the quantity of oxygen abstracted from the oxide by the combustible elements of the ether. But of these 3.28 grs., 2.2251 went to the formation of the carbonic acid, leaving 1.0546 of oxygen, equivalent to 0.1318 of hydrogen. Hence, 1.4 ether, by this experiment, which is taken as the most satisfactory of a great number, seem to consist of

Carbon	0.8345
Hydrogen	0.1318
Water	0.4337
	1.4000

And in 1 gram we shall have

Carbon .	0.5960	3 atoms .	2.25 .	60.00
Hydrogen .	0.1330	4 atoms .	0.50 .	13.33
Oxygen .	0.2710	1 atom .	1.00 .	26.66
	1.0000		3.75	100.0

Or. 3 volumes olefiant gas $= 3 \times 0.9722 = 2.9166$
2 . vapour of water . $2 \times 0.625 = 1.25$

4.1666

which suffering a condensation, equal to the whole vapour of water, will give an ethereous vapour, whose specific gravity is 2.5.

The proportion of the constituents of sulphuric ether, deduced by M. Gay-Lussac from the experiments of M. Th. de Saussure, are 2 volumes olefiant gas + 1 volume vapour of water, which 3 volumes are condensed into 1 of vapour of ether, having a specific gravity = 2.58. The ether which I used had been first distilled off dry carbonate of potash, and then digested on dry muriate of lime, from which it was simply decanted, according to the injunction of M. de Saussure. Whether my ether contained more aqueous matter than that employed by the Genevese philosopher, or whether the difference of result is to be ascribed to the difference in the mode of analysis, must be decided by future researches.

By analogous modes of reduction, the following results were deduced from my experiments. I ought here to state, that in many cases the materials, after being ignited in the tube, and then cooled, were again triturated in the mortar, and subjected to a second ignition. Thus none of the carbon could escape conversion into carbonic acid. I was seldom content with one experiment on a body, frequently six or eight were made.

TABLE OF ORGANIC ANALYSES.

	Substance	Carbon	Hydrogen	Oxygen	Azote	Water	Excess
1	Sugar - - - - -	43.38	6.29	50.33		56.62	
							Oxygen
2	Sugar of diabetes - -	39.52	5.57	54.91		51.13	10.35
3	Starch - - - -	38.55	6.13	55.32		55.16	6. 3
4	Gum Arabic - - -	35.13	6.08	55.79	3 ?	54.72	7.15
							Hydrogen
5	Resin - - - - -	73.60	12.90	13.50		15.20	11.20
6	Copal - - - -	79.87	9.00	11.10		12. 5	7. 6
7	Shell lac - - -	64.67	8.22	27.11		30.51	4.82
8	Resin of guaiac - -	67.88	7.05	25.07		28.	3.93
9	Amber - - - -	70.68	11.62	17.77		20. 0	9.40
10	Yellow wax - -	80.69	11.37	7.94		8.93	10.39
11	Caoutchouc - - -	90.00	9.11	0.88		.99	9.00
12	Splent coal - - -	70.90	4.30	21.80		27.90	1.20
13	Cannel coal - - -	72.22	3.93	21.05	2.8	23.68	1.30
14	Indigo - - - -	71.37	4.38	14.25	10.	16. 0	2.52
15	Camphor - - -	77.38	11.14	11.48		12.91	9.71
16	Naphthaline - - -	91. 6	7. 7	0.70?		0.79?	
17	Spermaceti oil - -	78.91	10.97	10.12		11.31	9.71
18	Common oil of turpentine	82.51	9.62	7.87		8.85	8.64
19	Purified oil of turpentine	81. 9	11. 5	3. 6		4. 0	11. 1
20	Naphtha - - -	83.04	12.31	1.65		5.23	11.73
21	Asiatic castor oil - -	74.00	10.29	15.71		17.67	8.33
22	Alcohol, sp. gr. 0.812 -	47.85	12.21	39.91		41. 9	7.25
23	Ether, specific gravity 0.70	59.60	13. 3	27. 1		30. 5	9. 9
							Oxygen
24	Bleached Silk - -	53.69	3.94	31.04	11.33	35.43	2.55
25	Cotton - - - -	42.11	5.06	52.83		15.56	12.33
26	Flax, by Lee's process	42.81	5. 5	51. 7		49. 5	7. 7
27	Common flax - - -	40.74	5.57	52.79	0. 9	50.16	8. 2
28	Wool - - - -	53. 7	2.80	31. 2	12. 3	25. 7	8. 3
							Hydrogen
29	Cochineal - - -	50.75	5.81	36.53	6.91	39. 6	14. 1
30	Cantharides - - -	48.64	5.99	36.29	9.08	40.83	14.53
31	Urea - - - -	18.57	5.93	43.68	31.82	49.14	0.47
32	Benzoic acid - -	66.74	4.91	28.32		31.86	1. 4
							Oxygen
33	Citric acid - - -	33.00	4.63	62.37		41.67	25.33
34	Tartaric acid - -	31.42	2.76	65.82		24.81	43.74
35	Oxalic acid - - -	19.13	4.76	76.20		42.87	38.09
36	Ferroprussic acid - -	36.82	27.89	of iron	35.29		

In his remarks upon the results announced in the above table, Dr. Ure has added much valuable information, but they are too extended for our entire insertion, and too connected to admit of abridgment. His candid discussion of the application of the atomic doctrine will, we trust, furnish an example of caution to some of his contemporaries who have shewn themselves more inclined to theory than experiment. Upon the very difficult subject of ferro-prussic acid, Dr. Ure has still left *us* in doubt, we mean as to its nature. We shall, however, conclude our extracts with his remarks upon that tantalizing compound,

Ferroprussic acid, the ferrocyanic acid of the French chemists, has proved, hitherto, a stumbling-block to me, in reducing the results of my experiments to the atomic theory. I have subjected it to very numerous trials in many states of combination, and have sought, with great pains, to accommodate the results to the doctrine of prime equivalents, but hitherto without success. The following facts, however, may, perhaps, be deemed of some consequence.

In the first place, the prime equivalent of the crystallized ferroprussiate of potash is 13.125, compared to oxide of lead 14, and to nitrate of the same metal 20.75; that is, 13.125 of the former salt neutralize 20.75 of the latter. In the second place, 14 parts of oxide of lead yield 21 parts of dry ferroprussiate of lead; or the atomic weight of dry ferroprussic acid is 7.

The mean of my analyses of ferroprussiate of lead, gives the relation of the constituents of the acid, as marked in the table. These proportions, reduced to the atomic weight 7, afford

Carbon	2.5774
Azote	2.4703
Ferreous matter	1.9523
	7.0000

Were we to suppose the prime equivalent of the ferroprussic acid 7.5, instead of 7; and were we farther to suppose that the carbon in the above result should be 2.25 = 3 atoms, and the azote = 3.5, or 2 atoms, then we might conceive an atom of dry ferroprussic acid to be made up of

Carbon	3 atoms	2.25
Azote	2 ——	3.50
Iron	1 ——	1.75

But experiment does not permit me to adopt this theoretical representation.

The best mode that has occurred to me for analyzing ferroprussiate of potash, is to convert it, by the equivalent quantity of nitrate of lead, into the ferroprussiate of this metal; then to separate the nitrate of potash by filtration; and, after evaporation, to determine its weight. In this way, 13.125 grs. of crystallized ferroprussiate of potash afford 12.33 grs. of nitre, which contain 5.6 of potash*. By heating nitric acid in excess on 21 grs. of ferroprussiate of lead, I obtained 2.625 grs. of peroxide of iron, equivalent to 1.8375 of the metal. Hence I infer, that the iron in the ferroprussiate of lead is in the metallic state; for the joint weights of the carbon and azote contained in 7 grains of the dry acid is 5.0477; and the difference, 1.9523, approaches too closely to the above quantity, 1.8375, for us to suppose the metal to be in the state of protoxide. In fact, 2.625 parts of peroxide × 0.9 = 2.3625 of protoxide, is a quantity much beyond what experiment shows to be present.

III. *An elementary Treatise on Mineralogy and Geology, designed for the use of Pupils, for Persons attending Lectures on these Subjects, and as a Companion for Travellers in the United States of America. Illustrated by Six Plates. By* Parker Cleaveland, Prof. of Mathematics, *&c.* in Bowdoin Col. 2d. edit. 2vols. 8vo., pp. 818. Boston—Cummings & Hilliard.

Whilst science extends her empire in all directions over Europe, she is not unmindful of the Western world, but is rapidly establishing a new throne on the vast continent of North America, and where, till within a comparatively short period, wilds

* By careful desiccation 1.69 grains of water may be separated from 13.125 grains of the salt.

and forests echoed with yells and howlings, her mild persuasive voice is now listened to with delight in populous and wealthy cities. The volumes before us confirm this truth; and it is alike honourable to the author, and his fellow-citizens, that a second edition of this valuable work has been so soon called for. Mineralogy is a study which should, and does, excite an intense and increasing interest amongst the inhabitants of the United States, whose almost boundless territory, eminently fertile, as the pages of this work evince, in the objects of mineralogical science, will amply repay them for their labour in exploring it.

The first 97 pages of the treatise contain an introduction to the study of mineralogy, divided into four chapters. The first consists of definitions, and preliminary observations. Although there be nothing new in this chapter, it opens the subject neatly, and contains some judicious remarks. Wernerians divide mineralogy into oryctognosy, chemical mineralogy, geognosy, geographical mineralogy, and economical mineralogy. Our author discards the first and third terms, which he very properly observes "have been unnecessarily introduced into the English language from German writers," and uses the older and better words, mineralogy and geology; defining the business of the former to be the study of simple minerals, or such as have their elementary principles so blended that they appear uniform and homogeneous to the eye, whilst compound minerals, as rocks, belong to the latter. We exposed the absurdity of the term oryctognosy in our last number, and we are happy to find our opinion in unison with that of so respectable a writer as Mr. Cleaveland. The passion for besetting the approaches of science with a vile *chevaux de frise* of hard names cannot be too often, or too earnestly, reprobated; and closely allied to this pedantry are the mineralogical and chemical symbols lately introduced by Berzelius. An admirable comment, not merely on the inutility, but the absolute mischief of the latter, may be found in the *Annals of Philosophy.* (Volume iv., new series, p. 409). In a former number the editor has given the first part of Berzelius's memoir on the sulphurets, and intended to have furnished an abstract of the remaining portion in the present; but having concluded that part which relates to the alcaline sulphurets, he refers his reader for the remainder to the original paper in the *Annales de Chimie*, adding, "This paper is replete with the symbols peculiar to Berzelius, and they are so generally unaccompanied by any explanation, that it is extremely difficult to *reduce them to an intelligible form*; for example, in about twenty lines there occur eight symbols of the following kind, $As\ S^3 + 6\ Ag\ S^2$." Here the English reader actually loses much valuable matter, in consequence of its being involved in these abominable symbols.

Chapter II. *Properties of Minerals.*—The aggregate properties of minerals constitute their characters, which are divided into physical and chemical. Crystallization, as the most important physical character, takes the lead. The student will find much information, clearly detailed, relating to this subject; but as originality cannot be expected on so often repeated a theme, we shall not stop to examine it in detail. We wish the author, had devoted a page or two in this chapter, under the head "*Forms of the integrant particles,*" to Dr. Wollaston's Theory of the spherical or spheroidal form of the ultimate particles of crystals. To pass over so interesting a subject with no other notice than the mere statement, in a note of three lines, that such ideas have been entertained by *some philosophers,* is, to say the least of it, a very censurable neglect in an elementary treatise. Dr. Wollaston's "simple and satisfactory elucidation of the principles of crystalline arrangement, has solved the difficulties, and remedied the inconsistencies of all previous explanations of the phenomena*;" and the omission we complain of has, consequently, left a deplorable gap in the subject. The next article is on the structure of secondary forms, in which the laws of decrements, *&c.*, are explained in the usual manner, and by references to the usual figures. Beudant's experiments on the effect of a foreign substance, though in a state of mixture only, to modify the crystalline form; and Daniells, on its developement by solution, are briefly noticed in this place. In the *Description of the Goniometer,* a plate should have been given of the reflective goniometer of Dr. Wollaston, as well as a more minute account of that instrument, and the mode of using it. As Carangeau's, or the common one, is figured, we do not comprehend why a drawing of the more complex and superior instrument has been withheld.

Description of Crystals.—Useful and clear, but not susceptible of abridgment.

Nomenclature of Crystals. This division is a literal translation, or very nearly so, of that part of the first volume of Haüy's *Traité de Minéralogie,* which contains the *Principes de la Nomenclature;* our author employs the *original* terms, "for the analogy of our language does not appear to justify a literal translation of many of the terms of this nomenclature." We do not quite see the necessity of this; in some cases it may be difficult to translate them into English words in common use, but are not many of the *original terms made* for the occasion, as *monostique, plagièdre, metastatique?* &c. In fact, they are Greek roots with French branches, and might just as well have English ones; and as to the rest, surely, in an English work, *cubic, cuboidal, tetrahedral,* &c., sound and look much better than *cubique, cuboide, tetraèdre,* &c.

* Daniell. *Journal of Science,* vol. i, p. 49.

Physical or External Characters occupy the next section. "The properties of minerals are somewhat numerous." Rather so,—witness the following table. *Colour. Changeable Colours. Lustre. Transparency. Refraction. Form. Surface. Touch. Coldness. Odour. Taste. Adhesion to the Tongue. Soil. Streak and Powder. Distinct Concretions. Flexibility and Elasticity. Sound. Cohesion. Hardness. Frangibility. Structure. Fracture. Shape of Fragments. Tenacity. Magnetism. Electricity. Phosphorescence. Specific Gravity.* In all twenty-eight! We shall skim hastily over this long Wernerian catalogue, referring our readers to the work itself, or any other which details and delights in all the minutiæ of the school of Freyberg, for more ample particulars, and leave their brains to comprehend, and their eyes to distinguish, if they can, the meaning and shades of "*bronze yellow,* which is brass yellow, mingled with gray," "brass yellow," being "sulphur yellow," ("which is pale, and has a shade of green,") "with a shade of gray, and a metallic lustre."

Refraction. The remarks on this subject are, in general, well given; though the conclusion of the following paragraph is a little whimsical. The author is describing the method of observing the double refraction of crystals, when the two images are so close together as not to be perceptible by common means.

> Make a very small puncture in a card, or piece of pasteboard; and having closely applied the card to that side of the crystal most distant from the eye, look through the crystal and the puncture at a candle, placed at some distance from the eye in a dark room. (*A lighted candle,*—else not visible—in a *dark room*!) The two images are quite distinct. p. 49.

Hardness. Instead of the usual method by the file or knife, for ascertaining the comparative degrees of hardness of minerals, it is more definite to determine in what order they "impress or scratch each other." "Thus, in the series, diamond, sapphire, chrysoberyl, garnet, quartz, feldspar, phosphate of lime, carbonate of lime, and sulphate of lime, each mineral is scratched by that which precedes it."

Magnetism. The author employs the term *double magnetism,* the result depending on the combined action of the magnetism of the earth, and that of a magnetic bar, to denote the method of rendering sensible extremely minute quantities of magnetism in minerals, suggested by Haüy, and which we need not describe in this place; nor can we stop to particularize the merits of the next section, *Electricity,* of which it is sufficient eulogy to say, that Mr. Phillips has quoted no inconsiderable portion of it in the introduction to the second edition of his mineralogy.

Section 3. *Chemical Characters.*—The first of these is *fusibility,* the chief instrument for effecting which, is the blowpipe. Short directions are given for using that instrument and its accessory apparatus.

Action of Acids, and other Tests.—Very brief, and very common.

Chapter III. *Systematic Arrangement of Minerals.*—After some general, but pertinent, remarks, our author proceeds, with great clearness and ability, to give an account of the system of Werner. Its defects and merits are fairly stated. A short sketch of Mohs' *Natural History Method* follows; and in Section 3 is given the arrangement of minerals, according to their chemical composition. He reasons thus, for preferring a chemical arrangement:

The *species*, the most important division, ought to be first formed.

It must be extremely obvious, that those minerals which most resemble each other, belong to the same species. We are then to inquire, what constitutes the most perfect resemblance between two or more minerals. Can similarity of colour, form, fracture, hardness, &c., constitute a resemblance so perfect as that which arises from identity of composition? Or can a difference of colour, form, fracture, &c., establish so important a distinction between minerals, as that which is produced by dissimilarity of composition? Would not two minerals, both composed of phosphoric acid and oxide of lead, in the same proportion, belong to the *same species*, although the colour of one should be brown and that of the other green? Would not two minerals, composed of phosphoric acid and lime, in the same proportion, belong to the same species, although the forms of their crystals, essentially the same, should exhibit different modifications? In fine, can properties, liable to numerous variations from trivial and accidental causes, be supposed to establish the identity of two or more minerals, with that degree of evidence which is afforded by a well-ascertained similarity in composition? We hesitate not to answer these questions by saying, that the *true composition* of minerals ought to be the basis of arrangement; and by this only ought the species to be established. This only can give permanence of character to the species. The composition of a mineral, that is, the ingredients proper and essential to its composition, may remain unaffected by the accidental presence of certain foreign ingredients, which materially change several of the external characters.

Hence a species may be thus defined: *a collection of minerals, which are composed of the same ingredients, combined in the same proportions.*—p. 81.

To the question, whether chemical analysis be yet sufficiently perfect and accurate for the determination of the species, our author answers, that *it is*, as far as regards *the alkaline and earthy salts*, some species of *combustibles*, and almost every species of the *ores of the metals.*

There remains, however, one class of minerals, composed chiefly of different *earths*, combined in various proportions, such as garnet, feldspar, &c., whose composition is not yet sufficiently understood to be employed as the basis of specific or even generic arrangement.

For the present, therefore, some other mode or modes must be employed for the determination of the species of *earthy* minerals; and, when it can be ascertained, the primitive form, and also the form of the integrant particles, mark the species of *crystallized* minerals with great precision.

These principles (composition and primitive form) are the basis of Haüy's theory, " whose first object seems to have been to unite different crystallized varieties of the same species

about one common point as a nucleus or primitive form; and he was thus almost necessarily led to form an arrangement of *crystallized* minerals only." Assuming chemical analysis as the foundation of the arrangement, Haüy nevertheless appears to have been chiefly governed by the form of the integrant particles in determining the species. " But however perfect this system may be, in regard to the laws by which various secondary forms are derived from the same primitive form, it is not equally competent to establish a *mineralogical method*," and since the integrant particles of some species, really distinct, have precisely the same form, the character derived from that form, being less general, ought to be subordinate to the true composition.

Moreover, some minerals crystallize much less frequently than others. May not some never crystallize at all? Every species has integrant particles, and would not those integrant particles remain the same in their real nature, whether regularly arranged in a crystal, or collected into an amorphous mass? Minerals, therefore, which have never been seen crystallized, may constitute really distinct species; and though their number be small, their claims to that rank, if well grounded, ought to be asserted.

Having by this mode of reasoning shewn the insufficiency of primitive form, &c., to establish a mineralogical method for the determination of species, our author proceeds to recapitulate the principles on which he founds his own arrangement. These are, first and foremost, chemical composition, " the only sure criterion for determining the species." When this is wholly unknown, or known imperfectly, other characters, depending more or less upon it, must be employed; these are, crystalline form (especially the primitive) and structure,

The latter of which may be extended to foliated masses, not possessed of a regular form; for these often easily yield to mechanical division, and thus enable us to discover the primitive form.

When minerals, whose ingredients are capable of combining in various proportions, are crystallized, the form of the integrant particle may be of great use in limiting the species.

The form of the integrant particle, and the primitive form, may be useful in distinguishing the non-essential ingredients, " for whatever can be added to a mineral, or taken from it, without affecting these forms, may be considered foreign."

The secondary forms are also important, provided the angles of the crystal be accurately measured.

The nature of amorphous minerals, whether granular or compact, may often be ascertained by their intimate connexion with well-defined crystals, or even with laminated masses of the same substance; of this, epidote furnishes an important illustration.

When neither analysis nor crystalline form can be resorted

to, a provisional arrangement must be adopted, derived from a "well-chosen aggregate of those external characters which depend most intimately on the nature of the mineral."

The higher divisions are also determined "by the composition of minerals, or by some of their chemical properties."

A *genus* will therefore be composed of certain species, which possess some common ingredient, and resemble each other in their chemical properties. In selecting the common ingredient, a preference should be given to that which is most fixed and permanent. Thus all minerals which are composed of *lime united to an acid*, will form one genus, characterized by a common earth, and receiving its name from that earth.

An *order* will be composed of certain genera having *bases* of a similar nature. All the earths have certain common properties; hence all those genera, which have for their base *an earth united to an acid*, will form the order of earthy salts.

A *class* is formed by the union of several orders; but the relations which unite orders into classes must necessarily be more abstract and general than those which exist between the several species of a genus, or the several genera of an order.

The *subspecies*, *varieties*, and *subvarieties* (when necessary), are chiefly determined by the external characters. The general principles which determine the subdivisions, are,

1. The presence of any ingredient not essential to the species, but which nevertheless produces a considerable change in the specific gravity, fusibility, or other important properties of the mineral.
2. Difference of structure, or in the degree of cohesion of the particles; characters which enable us to recognise all the varieties of carbonate of lime, &c.
3. Colour, when sufficiently constant, though arising from ingredients not essential to the species.

Section 4. *Description of Minerals.*

Characters, which would be insufficient to establish a mineralogical method—that is, a *systematic arrangement* of minerals on certain *fixed principles*,—may be employed in their *description*, by which they are recognised and referred to their true place in a system *already formed.* Hence any character which almost uniformly belongs to a particular species, will be useful in describing it.

The primitive form, when ascertainable, should never be omitted, nor the accurate measurement of the angles of a crystal, "whether those formed by the inclination of contiguous faces to each other, or the plane angles of the faces."

The characters should be of easy and expeditious application, and the most important should be given first. The *geological* character should always accompany the description, for certain minerals are frequently found together, whilst others are never associated. The gangue, or matrix, should also be mentioned.

Chapter IV. *Nomenclature of Minerals.*—The first remark on this head is too true to be omitted.

The nomenclature of most minerals is at present so incumbered with synonyma, that it has become extremely perplexing to the student. The mineral called *epidote* by Haüy, is named *pistazit* by Werner, *thallite* by Lametherie, *akanticone* by Dandrada, *delphinite* by Saussure, *glassy actylonite* by Kerwan, *arendalite* by Karsten, *glasiger strahlstein* by Emmerling, and *la rayonnante vitreuse* by Brochant.

Besides this abominable deluge of names for the same substance, the same name is sometimes applied by different writers to substances perfectly distinct.

Where the chemical nomenclature cannot be applied, it would perhaps be a good rule to adopt the name given by the discoverer of the mineral.

Our author's plan is to adopt the chemical nomenclature for the *species*, in all cases where the composition is sufficiently known, with a familiar mineralogical name, and the synonyma of some of the most valuable modern writers. Subspecies and varieties are distinguished by mineralogical names already in use and well known. Earthy minerals of uncertain composition are generally named after Kirwan and Jameson, with such deviations from their nomenclature as the progress of the science has called for.

A brief enumeration of the substances of which minerals are composed closes this part.

We have next a tabular view of our author's arrangement. "The divisions into species, and the nomenclature of the species, are perhaps as strictly chemical as the present state of mineralogical knowledge will permit." The class of earthy compounds, which cannot be accurately divided into genera, have their species arranged after their composition, those most alike being collected into the same group. No ingredient, not amounting in an apparently pure specimen to at least five per cent., is considered essential; and others, "in greater proportion, in obviously impure specimens, have been rejected as accidental." This is rather a loose method of determining whether an ingredient be essential to the composition of a mineral or not. The weights of the absolute quantities of the several substances, given by the analysis, should rather be compared with those of their respective prime equivalents. This affords, at once, solid data for estimating the value of any ingredient, and the probable accuracy of the analysis.

The tabular view occupies eighteen pages: we can only give a very slight outline of it.

The substances are divided into four classes. The first class comprehends substances not metallic, composed, entirely or in part, of an acid. It contains four orders. Order 1.—*Acids not combined.* The base of the acid determines the genus. Order 2.—*Alkaline Salts.* The alkali determines the genus. Order 3.—*Earthy Salts.* The earth determines the genus. Order 4.—*Salts, with an alkaline and earthy base.*

Class 2. *Earthy Compounds, or Stones.*—Composed chiefly of earths combined with each other; they frequently contain some metallic oxide, and sometimes an alkali or acid. This class contains 90 species, arranged according to their chemical composition, which is denoted on the outside of a bracket, on the left hand of the respective groups. The first consists of silica nearly pure, *quartz*, &c. The second, of alumina nearly pure, *sapphire*, &c. Then succeed the compounds of alumina with water, magnesia, silica, &c., in which that earth is the chief ingredient, and proceeding from the more simple to the more complex combinations. After these come the compounds of yttria, and of zirconia, with silica, &c.; and lastly, those (by far the most numerous) in which silica is the principal element, in combination with one or more of the other earths. This arrangement obviously bears a close analogy with that adopted by Mr. Wm. Phillips. At the end of this class are placed 22 species not yet analyzed.

The third class comprehends the combustible substances, and we were somewhat staggered at seeing *hydrogen gas* stand at their head. In the *Natural History Method* we are *not* surprised to see it, but *here* we are both surprised and sorry. After hydrogen, come sulphur and the other combustibles, including diamond, and

The fourth class is devoted to ores, beginning with gold, platina, &c., and ending with selenium and cadmium.

The descriptions of the species in the body of the work are ample, without being diffuse, and always clear. The general description is usually succeeded by that of the *chemical characters*, *distinctive characters*, and *geological situation and localities.* The latter head is particularly useful, as respects the mineralogy of the United States of America. We regret that our limits forbid us to quote any instances of Mr. Cleaveland's style, in this important part of his book; we hope its universal distribution will render the omission of little consequence.

The same want of space compels us also to notice, much more cursorily than we could wish to do, the remaining part, the *Introduction to the Study of Geology.* After some general remarks, and the explanation of the terms *primitive* and *secondary*, as applied to rocks, a description of their relative ages and positions, &c., the author sums up the whole in the following general principles, which he considers as "satisfactorily established:"

1. The minerals which compose the external crust of the globe, from the summit of the highest mountain to the lowest point hitherto explored, must at some former period have been in a fluid state, and the solvent must unquestionably have been caloric or water.

2. There appears to be sufficient reason for believing that by far the greater number of minerals have been deposited from a state of solution or suspension in water; and of course, that the sea, in a more or less tranquil

state, has at some former period, for a considerable portion of time, covered the tops of the highest mountains. The distinctly crystalline structure of most of the primitive rocks, and the numerous regular crystals which they contain, decidedly indicate a previous state of fluidity. And it seems no less certain that this solvent must have been water.

The numerous organic remains which exist in secondary rocks unquestionably prove that such rocks have been deposited from water. It is well known, that different sorts of secondary rocks have been deposited at different and successive periods; and it is equally evident, from an inspection of the organic remains in secondary rocks, that this ancient sea was *successively* peopled by different races of animals.

Such, indeed, may be the commonly-received opinion, but common opinion is not convincing proof, and to a subject so purely hypothetical, a less confident style than prevails in the preceding quotation had been better adapted. We are not inclined, even if we had time, to enter into the comparative merits of the fire and water fancies, miscalled theories; but we have certain old-fashioned prejudices, which in these *enlightened* days of *scepticism* and *infidelity* will no doubt be set down as mightily ridiculous, but which, nevertheless, induce us to pause before we acquiesce either in the one or the other. There *is* another mode of accounting for the present state of the earth's structure, on principles at least as rational, in a philosophical light, as either the Plutonian or Neptunian; and, inasmuch as it is more consistent with, and founded on, Sacred History, incomparably superior *.

Our author avowedly inclines to the Wernerian hypothesis, yet he candidly acknowledges the difficulties by which it is surrounded.

Cumming and Hilliard's map is prefixed to the first volume, shewing, by its colouring, the general bearings of the great geological districts of the United States. The following short extracts from this interesting part of the work will enable our readers to trace their outlines on any good map of that country.

1. *Alluvial Deposite.*—The northern extremity of this deposite is at Long Island, all of which appears to be alluvial, excepting the margin of the shore at Hurlgate, where primitive strata appear for the distance of four or five miles. On the east and south-east, this alluvion is bounded by the Atlantic; and on the south, by the Gulf of Mexico, to the Mississippi. Its north-western, or interior boundary, commencing a little below Newark, runs north of Amboy to the Raritan, and thence passes near Trenton, Philadelphia, Baltimore, Washington, Fredericksburg, Richmond, Petersburg, a little west of Halifax, Smithfield, and Averysborough in North Carolina, and of Camden in South Carolina, near Columbia, Augusta on the Savannah, and thence, bending to the west, it crosses the Ogeechee, Oakmulgee, Alabama, and Tombigbee rivers, and reaches the Mississippi a little below Natchez.

The great mass of this alluvial deposit, below the soil, is composed of sand, gravel, pebbles, and clay, the last of which, either white or variously coloured, sometimes forms extensive beds.

2. *Primitive Rocks.*—The primitive formations extend from north-east to south-west, through nearly the whole territory of the United States. *East-*

* See Mr. Granville Penn's *Comparative Estimate of the Mineral and Mosaical Geologies.*

ward of the Hudson, the rocks are, with a few exceptions, entirely primitive, and have the Atlantic for their eastern boundary. The apparent breadth of this primitive tract is much diminished in the middle states; but in the southern states is again enlarged. From the Hudson to the Tombigbee, its visible boundary, on the south-east, is, with a very few exceptions, the aforementioned alluvial deposite; under which, however, it undoubtedly extends more or less. Its north-western boundary, after crossing the parallel of 45° N. latitude, runs fifteen to twenty miles east of Lake Champlain, twelve miles east of Middleburg, and a little westward of Bennington in Vermont, twelve to fifteen miles east of Hudson, and twelve miles south-east of Poughkeepsie in New York; it then bends to the south-west, crosses the Hudson, passes near Sparta, and ten or fifteen miles east of Easton on the Delaware, terminating in a point a few miles north of Bethlehem; it again appears fifteen miles west from Trenton in New Jersey, runs about fifteen miles west of Philadelphia, ten miles east of York, and passing about twenty-two miles west of Washington, joins the Blue Ridge, along which it continues to Magothy Gap, and thence passes in a south-westerly direction, till it meets the alluvial deposite near the river Alabama.

Primitive rocks also appear westward of Lake Champlain, and have for their general boundaries, Lakes Champlain and George on the east, the St. Lawrence on the north-west, and a line drawn from the Thousand Islands in the St. Lawrence, passing near the Mohawk, and terminating at Lake George, on the south-west.

3. *Transition Rocks.*—Several transition and secondary formations, of comparatively small extent, are found within the limits assigned to the primitive rocks; but the greater part of the transition rocks found in the United States, lie north-west of the primitive, and form a long and narrow zone, extending from a little north-east of the Hudson, nearly to the river Alabama. The breadth of the zone is from twenty to one hundred miles.

4. *Secondary Rocks.*—This great deposit lies north-west of the transition rocks, extending from them to the Lakes, and from the Hudson to the westward of the Mississippi. This deposite is equally remarkable for the extent and uniformity of the formations which it embraces, and which consist of limestone and sandstone in strata nearly horizontal, on which often rests the independent coal formation. According to Mr. Maclure, there is reason to believe that this secondary deposite extends westward of the Mississippi, nearly to the foot of the Stony Mountains; thus presenting an area, whose diameter from east to west is about fifteen hundred miles, and from north to south about twelve hundred miles.

A useful Vocabulary of scientific terms, and a copious Index closes the work. Five plates, besides the map, are added. The figures are well executed in outline, and consist chiefly of the forms of crystals, with some of dissected crystals, the goniometer, &c.

The lengthened attention we have bestowed on this work, almost renders it superfluous to add that we think highly of it. It is not faultless; but its faults are few. Somewhat of unnecessary repetition occurs occasionally in the introductory part, and now and then the arguments are not put with perfectly logical clearness and precision; but these instances are rare, and never serious, and in bidding Mr. Cleaveland farewell, we thank him for the pleasure and information he has afforded us, and congratulate our brother mineralogists of the Western Hemisphere, that a teacher of the science has arisen amongst them, "*tali ingenio præditum.*"

Art. XV.—ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XII.

i. *Remarks on the Zodiac of Dendera, by the Author of the Article* Egypt, *and by* Mr. Champollion, junior.

"From the chronology of Egypt we may pass very naturally to the consideration of its calendar, which has often been a subject of speculation both with critics and with astronomers. The inquiry is in itself somewhat intricate; but the principal difficulties have arisen from the ignorance or carelessness of the Greek authors, who have written on the Egyptian mythology. The Baron Alexander von Humboldt and M. Jomard have displayed great learning and research in collecting authorities on this subject; and nothing is wanting to establish the propriety of their acquiescence in the opinion of Petavius, except a little less indulgence for the extreme inattention of Plutarch, and a more marked deference to the important testimony of Eratosthenes, a writer whose catalogue of the Egyptian kings has already been noticed, as bearing intrinsic marks of the authenticity of his information, and whose competency, as an accomplished astronomer, to discuss the regulation of the calendar is of still greater notoriety. Geminus, a Greek astronomer of the Augustan age, has very distinctly stated, that the later Greeks had been in the habit of mentioning the Egyptian festivals as connected with particular seasons of the year, in spite of the clearest evidence that their mythological year consisted of 365 days only, and that their anniversary festivals must necessarily have passed in succession through every part of the natural year. 'It is a common and inveterate error among the Greeks,' says Geminus, 'to believe that the festival of Isis happens at the winter solstice. This was indeed true 120 years ago, but it is now a month earlier; and such a mistake betrays the grossest ignorance of the Egyptian calendar. In former ages this festival was celebrated not only as late as the winter solstice, but, at an earlier period of time, even at the summer

solstice; as Eratosthenes expressly states, in his COMMENTARY UPON THE OCTAETERIDES (*Geminus in Petavii Uranologia.* Par. 1630, f. P. 33.) . . .

"It is of importance, in the discussion of some representations of astronomical objects, to determine at what time of the year the sun entered the respective signs, according to the Egyptian calendar, or more particularly, what was the sun's place in the starry zodiac at the commencement of the year, for different periods of time. Taking, then, $6^h\ 9^m\ 8^s$, for the excess of the sidereal above the Egyptian year, we find that 1424 Julian years were required for a complete revolution of the sun's place on the 1 thoth, and 119 for each sign. Now since, about a century before the establishment of the Julian calendar, the sun entered Libra on the 24th of September, and since the Egyptian year began on that day, in 120 B. C., it follows that Libra had been the first constellation during the whole of the preceding century; for, at this period, the beginning and end of the signs of the ecliptic agreed very nearly with those of the corresponding constellations of the zodiac. The first constellation of the Egyptian year will therefore stand nearly thus:

From 1552 B. C.	. 484 ♑
to 1433, ♍	365 ♐
1314 ♌	247 ♏
1196 ♋	128 ♎
1077 ♊	9 ♍
958 ♉	A. C. 110 ♌
840 ♈ .	228 ♋
722 ♓	347 ♊
603 ♒	

"If we attempt to determine the date of a given monument from astronomical symbols contained in it, we must suppose that they represented the state of the heavens with respect to the Egyptian year at the time in question. Thus, in the zodiacs of the ruins at and near Esne or Latopolis, the constellation Pisces seems to be the first sign, as it really was, about 800 B. C., or in the time of Bocchoris and of the Ethiopian dynasty. It is, however, equally possible, that Virgo may have been in-

tended for the first sign, and this would answer either to *the century immediately preceding the birth of Christ*, or to a period fourteen centuries earlier. The zodiac at Dendera appears to begin with Leo; and unless we suppose its antiquity extravagantly great, we must refer it to *the time of* TIBERIUS, as Visconti has indeed already remarked. Mr. Hamilton has confirmed this opinion by the collateral evidence of inscriptions in honour of the Roman emperors: although, with respect to the difference of time implied by the difference of a sign in the beginning of the zodiacs, he is rather inclined to adopt the sentiments of Lalande, who refers it to the effect of the precession of the equinoxes; imagining, without any kind of authority, that the division of the signs corresponded to the period of the solstices, a period which never constituted a marked feature in the Egyptian calendar." . . .

"The beetles in the [square] zodiac of Dendera have a very different signification, and THE WHOLE REPRESENTATION IS MUCH MORE OF A MYTHOLOGICAL THAN OF AN ASTRONOMICAL NATURE."—*Supplement to the Encyclopædia Britannica,* IV. *Edinb.* 1818., *Article* EGYPT, *Section* IV.

"Some of our journals," says Mr. Champollion, "have published an abstract of a Memoir on the Zodiac of Dendera, read by M. Biot to the Royal Academy of Sciences, the 15th and 22d of July, and communicated the 19th to the Academy of Inscriptions and Belles Lettres. This able mathematician having undertaken to investigate the nature of the projection employed in this zodiac, from the places assigned to some principal stars, supposed to be recognised, has inferred from his researches that the date of the monument must have been 716 B. C.

"Here, then, we have a new opinion upon the epoch to be attributed to an astronomical representation, which, for twenty years, has been successively the occasion and the subject of a multitude of systems, all conflicting with each other, according to the different degrees in which those who have wished to explain it, and to infer rigorous conclusions from it, have been

more or less prepared by the nature and subjects of their previous studies, for undertaking so difficult a task.

" It is not sufficient, in fact, to possess in perfection the mathematical theory of modern astronomy; it is also necessary to be acquainted with that science such as it was among the Egyptians themselves, with all its errors, and in its original simplicity. If he is not thoroughly impressed with the idea, that the astronomy of Egypt was essentially mixed with its religion, and even with that false science, which pretends to read in the heavens the future destinies of the world and of its inhabitants; the bold explorer of the monument of Dendera must find himself on dangerous ground; he is liable to mistake an object of worship for an astronomical character, and to consider a representation purely symbolical, as the image of a real object, and a part of the picture before him.

" A second rock, and that on which most of the explanations of the Egyptian zodiacs have struck, is the difficulty of distinguishing, in these ancient representations, the images which are actually intended to represent, either simply or figuratively, the celestial figures or *signs*, from the characters which belong solely to the Egyptian system of *writing*, and which only appear on the zodiacs as signs of *ideas*, with which their forms have frequently no relation whatever.

" This distinction can only be made by means of a long intimacy with Egyptian monuments; and it may be observed, that hitherto few antiquarians have been aware of its extreme importance. Most of them have confounded, under the name of *Hieroglyphics*, both the hieroglyphics properly so called, that is to say, the pictural elements of the Egyptian writing, and the actual figures of gods, and men, and sacred animals, which are always accompanied by inscriptions purely hieroglyphical. We have seen some long essays, for example, which have professed to contain *an explanation of the hieroglyphics*, and which have not even made mention of a single character truly hieroglyphical.

" If, then, it should have happened that the considerations here stated did not occupy, in the Memoir of M. Biot, quite so

much space as naturally belonged to them, it would not be surprising if the foundations of his reasoning were somewhat deficient in the certainty required for calculation. Without entering, therefore, into his modes of arguing and his geometrical inferences, because I have always thought it best to avoid speaking of subjects with which I am not well acquainted, I shall here examine only those foundations which are of an elementary nature, and of a material form, and which M. Biot obtains immediately from the monument in question.

"The elements of his investigation consist in the determination of four principal stars, of which three are of the first rank. *Fomalhaut*, *Antares*, and *Arcturus*, and lastly, the second star of Pegasus, named *Sheat*.

"If the reader will cast his eye on the lithographical representation of the zodiac, published by M. M. Saulnier and Lelorrain, and will place immediately before him the sign Pisces, he will see, to the right of this sign, a figure of a man, standing, with a sceptre in his hand, and having on his head *a star*: it is this which M. Biot calls *Sheat*.

"Directly below the feet of the same figure we see another star accompanied also by some small hieroglyphical signs: this, according to M. Biot, is *Fomalhaut*.

"Between the Scorpion, and one of the scales of Libra, is a monstrous figure, with a human head, with the feet of a hippopotamus, and a long tail, stretching out his arms, and holding in one of his hands an object which M. Biot believes to be a star, and which he calls *Antares*.

"Lastly, between the second scale of the balance and the figure of the Virgin, is a personage with the head of a bullock, having a star before his face, which M. Biot has named *Arcturus*.

"It is merely the degree of reliance that can be placed on the application of these names that I propose to examine; and I trust that the length of the time, that I have devoted to the study of the monuments of ancient Egypt, will allow me to undertake this task without presumption.

"If we consider attentively the whole character of the zodiac

we shall observe in it a great number of figures of men or of animals of different shapes, almost all of which are *surmounted* or *preceded* by a little group of hieroglyphical characters, disposed either on the same line, or some above the others; and all these groups contain one star. They are in number at least thirty-eight, five of which belong to figures within the zodiac, and the thirty-three others to the figures of men or animals, of which the feet rest on the circumference of the great disc enclosing the zodiac.

"The analogy of the *position* of the stars, in these hieroglyphical groups, establishes necessarily between them an analogy of *expression;* and if four of these *stars* are really representations of Arcturus, Antares, Fomalhaut, and Sheat, it follows of course that the thirty four others must also be the representations of so many principal stars existing in the heavens; and further, if we assert, with M. Biot, that the stars which he names Arcturus, Antares, Fomalhaut, and Sheat, are represented in the zodiac nearly in the positions which they actually occupy in the heavens, we must allow that the thirty-four other stars are also sculptured in their true places.

"We should, therefore, only have to look them out in a map of the heavens, by observing their positions and their relative distances, as expressed on the monument of Dendera, and especially by setting out with the comparison derived from the well-known situations of the former four.

"Now such a mode of proceeding, which would be extremely easy if the state of things were such as is supposed, becomes, in fact, totally impossible; since thirty-five of these stars, including that which would be called Fomalhaut, are arranged *symmetrically* on the monument, and form a circle concentric with the whole representation. Now nothing like this is to be found in the heavens.

"It must, therefore, unavoidably be admitted, first, that these thirty-five figures of stars cannot represent of themselves any stars in the heavens, and that they do not stand in their places; secondly, and consequently, that the two other images of stars named by M. Biot, cannot represent Arcturus and Sheat,

because these two last are comprehended in the hieroglyphical groups, like the thirty-five others. As to *Antares*, Mr. Biot seems to have given up the question, by admitting that the monstrous figure placed between the Scorpion and one of the scales of the Balance, does not hold a star in his hand; and, in fact, the thing intended is really a vase, as may be observed by inspection of the monument itself, or even of the lithographical drawing, and by a comparison with the rectangular zodiac of Dendera, on which this figure is seen by the side of the Scorpion, holding two vases in its hands. All the existing drawings of this second zodiac agree in this point.

"But since these thirty-eight figures of stars, grouped together with hieroglyphical symbols, do not really represent any celestial bodies, or at least do not shew their relative places, it remains for us to examine what office they really perform on the monument of Dendera: and all the remains of Egyptian sculpture will agree in affording us a satisfactory answer.

"It is certain, ['*Nous' avons reconnu*] that every hieroglyphical group, placed on the head or by the side of the image of a deity, a man, or an animal, expresses the proper name of the object, or at least a peculiar and characteristic designation. This assertion is proved by innumerable examples. The short hieroglyphical inscriptions, which stand on the zodiac of Dendera, above or by the side of the thirty-eight figures in question, can therefore only be their proper names. Consequently, the star termed Fomalhaut belongs to the proper name of Aries placed immediately below it, with its feet touching the circumference of the disc: Arcturus is a part of the proper name of the figure with a bullock's head, and Sheat of that of the personage standing and holding a sceptre. The positions of real stars that might be deduced from these representations are, therefore, without any foundation, since the representations are only constituent parts of the proper names belonging to the pictures of the personages, which could alone be considered as holding the places of the constellations, even if it were allowable to attach any great importance to their relative situations, as fixing their true positions; which is however extremely impro-

bable: for these stars are really nothing else than hieroglyphical elements of so many proper names.

"There is no doubt that every hieroglyphical inscription begins on that side to which the faces of the living objects represented in it are turned. The star in the short groups at Dendera is therefore the *last* hieroglyphic character of each of them, and must be considered, not as the representation of a star, but as a simple element of the hieroglyphical writing; that is to say, as a sort of letter, and not as the imitation of an object. It now remains to be explained why these thirty-eight groups are all terminated by a star.

"The study of the three systems of writing of the ancient Egyptians, founded on the infallible basis of the comparison of the three parts of the inscription of Rosetta, has convinced us that the great part of the proper names of *individuals* belonging to the same *species*, are always preceded or followed by the hieroglyphical character denoting that *species*. It is thus that all the names of the gods and goddesses end with the character which expresses the idea of *god*, (for example, in the zodiac itself, the names of Isis, Osiris, the Moon, Horus, ["Hyperion"], and Thoth;) and that the proper names of the months are preceded by the sign of the idea *month*.

"It appears therefore evidently, that in the thirty-eight short inscriptions which are attached to thirty-eight of the figures of the zodiac of Dendera, the star is merely the hieroglyphical sign of the *species* comprehending the *individuals* which are indicated by these inscriptions.

"It may consequently be inferred, that these personages must be the representations of stars, of constellations, or of parts of constellations; and it was natural that their hieroglyphical names should contain the hieroglyphical sign of the *species*, that is to say, a *star*, in the same manner as the proper name of every Egyptian divinity contains the particular sign *god;* and in the same manner also as, in the language as spoken, the syllable SOU, contracted from SIOU, which signifies *star*, entered into the composition of the proper names of the stars or of the constellations, such as SOUNHÔR, *the star of Horus*, or Orion

Sourot, *the star of Venus*, or otherwise, the *great bear*, according to an Arabic interpreter (Coptic MS. in the king's library, Fonds de St. Germ. Suppl. N. xvii.); Sounouhor, the *great dog*, or the *star of Canopus.*

"But this is not the place for entering into a more full explanation of these different names. We have only proposed to examine in what degree M. Biot was authorized to give to some of the numerous stars, which appear in the zodiac of Dendera, the names of any known stars, in order to find a date for the monument: and it appears that the observations, which we have offered on this subject, must at least throw great uncertainty on this very important part of the Memoir of a celebrated Mathematician, who has, in other respects, by the multitude of his valuable works and his interesting discoveries, acquired so just a claim to the gratitude of the public.

"The study of Egyptian antiquities is now acquiring from day to day a greater degree of certainty: the time is come when we must renounce all those conjectural speculations, which have too long prevailed in this study without control. A variety of authentic monuments are poured in upon us from all quarters, and the comparing them with the multitude of passages relating to them, which are left in the works of the ancient authors, will hereafter be the only unerring guide in all researches into the history and the arts of a nation placed so high by antiquity itself in the annals of every kind of civilisation."—*Lettre à M. le Rédacteur de la Revue Encyclopédique, relative au Zodiaque de Dendéra.* R. E. N. xliv. Août 1822.

ii. *Extract from Laplace's History of Astronomy.*

Since the publication of the Remarks on the Exposition du Systême du Monde, in the last Number of these Collections, the illustrious author of that work has favoured the writer of those remarks with a copy of his late republication of the fifth book of the Exposition, under the title of *Précis de l'Histoire de l'Astronomie.* 8. Paris 1821. The passage in question being no longer liable to the objections which were made to it in this Journal, it becomes necessary to insert it here in its improved form.

"The celebrity of his successor Eratosthenes is principally due to his measurement of the earth, which indeed is the first attempt of the kind that has been recorded in the history of astronomy. It is very probable that in much earlier times astronomers had not wholly omitted to make experiments of the same kind; but nothing has been left of these earlier operations, except some estimations of the circumference of the earth, which have been reduced, by means of comparisons more ingenious than demonstrative, to something like an agreement with more modern determinations. Eratosthenes having considered that at Syene, the sun, at the time of the summer solstice, shone into a well throughout its depth, and, comparing this observation with that of the meridian altitude of the sun at the same solstice, as observed at Alexandria, found the celestial arc, comprehended between the zeniths of these two cities, equal to the fiftieth part of the whole circumference; and as their distance was estimated at about five thousand stadia, he gave 252,000 stadia as the whole length of the terrestrial meridian. It is, however, very improbable, that, for so important a purpose, this great astronomer should have been contented with the coarse observation of a well enlightened by the sun. This consideration, and the relation of Cleomedes, authorise us to conclude that he observed the shadow of the gnomon at the summer and winter solstices, both at Syene and at Alexandria: and in this manner he obtained the difference of latitude of these two cities very nearly such as it has been found by modern observations. But the greatest uncertainty, that this measurement has left us, relates to the length of the stadium employed by Eratosthenes, which it is difficult to determine among the multitude of different stadia that were employed by the Greeks." P. 34, 35.

iii. *Elements of a Comet, communicated by* Professor SCHUMACHER.

THE comet now visible, 3 October, gives us still much labour. The totality of the observations of Dr. Olbers and my own,

are represented by the following elements, calculated by Mr. Hansen.

Perihelium 1822 October 23,57725, at Altona	
30^m. 30^s. from Paris	
Longitude of the Perihelium	271° 53′ 32″,4
Longitude of the ascending node	92 38 17 ,9
From the mean equinox of 1 Sept.	
Inclination	52 36 51,7
Logarithm of the Per. Distance	0.0597898
Motion retrograde.	

Our observations, compared with these elements, indicate nothing of ellipticity.

iv. *Remarks on the* GEOCENTRIC LATITUDE *of the Americans, as applicable to Occultations.*

It has been suggested, by some patriotic land surveyors on the other side of the Atlantic, that it would be much more correct to consider the latitude as determined by the position of the earth's diameter than by that of its surface: and this for a very obvious reason, that it would give to the United States ten or twelve miles of territory in breadth, and some hundreds in length, from the change of position of the line of demarcation between their territories and the British colonies. But in Europe the reason for departing from the received usage of language, as applied to the sun and the stars and the seasons, is by no means so cogent, and the simple denomination of *latitude* must still remain appropriated to the elevation of the pole above the actual horizon, or the plane touching the earth's surface at the point of observation.

The "Geocentric Latitude" of the American surveyors, however, is by no means a useless element in the problems of Nautical Astronomy: for it affords the simplest and most correct mode of determining the precise effect of parallax on the moon's place in the heavens. It is always *less* than the true latitude: the subtractive correction being equal to 11′ 14″ × sin. 2 lat.: and it will be convenient to employ a small table, similar to Mayer's, instead of a separate calculation, for obtaining it in each case.

TABLE *for finding the Geocentric Latitude.*

True Lat.		Correct.		True Lat.		Correct.	
°	°	′	″	°	°	′	″
0	90		0	23	67	8	5
1	89		24	24	66	8	21
2	88		47	25	65	8	36
3	87	1	10	26	64	8	52
4	86	1	34	27	63	9	5
5	85	1	57	28	62	9	19
6	84	2	20	29	61	9	31
7	83	2	43	30	60	9	44
8	82	3	6	31	59	9	55
9	81	3	28	32	58	10	6
10	80	3	51	33	57	10	16
11	79	4	12	34	56	10	25
12	78	4	34	35	55	10	33
13	77	4	55	36	54	10	41
14	76	5	16	37	53	10	48
15	75	5	37	38	52	10	54
16	74	5	57	39	51	10	59
17	73	6	17	40	50	11	4
18	72	6	36	41	49	11	7
19	71	6	55	42	48	11	10
20	70	7	13	43	47	11	12
21	69	7	31	44	46	11	13
22	68	7	48	45		11	14

We may take, for an example of the utility of this mode of correction, the occultation computed in the Astronomical Collections, No. III.

The elements of the calculation are, the true latitude of Paris 48° 50′ 14″, for which the correction is 11′ 8″, giving the Geocentric Latitude 48° 39′ 6″. The moon's horary angles are $3^h\ 6^m\ 8^s$, and $4^h\ 4^m\ 27^s$ east, and her declinations 51′ 19″ and 1° 6′ 6″ N.: the reduced parallax P. L. 5098 and 5096.

1. Log. ris. = L. vs $3^h\ 6^m\ 8^s$	4.49426		2. L. ris. $4^h\ 4^m\ 27^s$		4.71342
L. cos. 48° 39′ 6	9.81996		= L. sin. 41° 20′ 54″		9.81996
51′ 19″	9.99995		L. cos. 1° 6′ 6″		9.99992
n. 20614	4.31417		n. 34143		4.53330
N. S. 67177		Mer. A. 42° 12′ 13″	N. S. 67495		M. A. 42° 2 0
46563		G. A. 27° 45′ 4″	33352		G. A. 19° 28′ 57

L. Sec. G. A.		.05307		.02561
L. S. H. A.		9.86080		9.94229
L. Cos. G. Lat.		9.81996		9.81996
S. P. A.	32° 48	9.73383	37° 51′	9.78786
Given	62 2	Orbital angle	62 2	
	29 14	Par. Orb. A.	21 11	

P. L. H. P.		5098		5096
Log. Sec. G. A.		.0531		.0256
P. L. 49′ 15″		5629	52′ 29″	5352
27 45 4			19° 23 57	
			18 36 28	
Corr. 26 55 49	L. S.	.0498		.0233
P. L. Corr. P.		5596		5329
L. Sec. P. O. A.		.0592		.0399
P. L. 43′ 18		6188	48′ 8″	5728
L. Cos. P. O. A.		.3112		.3876
P. L. 24′ 14″		8708	21 37	9205
21 37			43 18	
2 37		Difference	4 50	

☽'s H. M. (31′ 30″) — (4′ 50″) = 26′ 40″ P. L.		8293
P. L.	2′ 37″	1.8375
L. tang.	5° 36′	8.9918
	62 2	
	56 26 Visible Pol. O. A.	
	32 48	
	23 38 Visible Par. O. A.	

P. L. Corr. P. in G. A.		5596	P L. Diff. Decl.	41′ 58″	6324
L. Sec.	23° 38′	.0380	L. sec.	56° 26′	.2573
P. L.	45′ 28″	5976	P. L.	23′ 12″	8897
L. Cos.	23° 38′	.3970	L. cosec.	56° 26′	0.792
P. L.	19′ 53″	9566	P. L.	34′ 58″	7116
				19 53	
	23 12			15 5 Distance	
	22 16			15 18 Semid.	
P. L. H. M.		8293	Sum	30 23 P. L.	7726
L. sec.	5° 36′	.0021	Diff.	13 P. L.	2.9195
P. L. Corr. H. M.		8272			3.6921

P. L. 1^h		4771
		3501
P. L.	32′ 16″	9076
P. L.	$49^m\ 52^s$	5575
	10 53 18	
	10 3 26 Middle	

Half sum	1.8460
P. L. for . HM.	3501
P. L. Semid. $5^m\ 45^s$	1.4959
10 3 26	
9 57 41 Immersion	
10 9 11 Emersion	

The effect of the earth's ellipticity appears therefore to shorten the duration from $15^m\ 16^s$ to $11^m\ 30^s$, the difference being $3^m\ 46^s$, as derived from the consideration of the "Geocentric" instead of the true latitude.

Art. XVI. PROGRESS OF FOREIGN SCIENCE.

CHEMICAL SCIENCE.

I. Laws of Combination.

On the Relation which exists between Crystalline Form and Chemical Proportions. By Mr. E. Mitscherlich.

(Continued from page 219.)

Of the Phosphate and Arseniate of Potash and Soda.

If we add carbonate of soda to the bin-arseniate, or bi-phosphate of potash, till we obtain neutral salts, the solutions crystallize entirely, as double salts. The solutions of the crystals precipitate muriate of barytes so that the liquid is neutral, and comport themselves with solutions of the metallic oxides like the neutral arseniates and phosphates. They are consequently at the same degree of saturation as these salts.

100 parts of this double phosphate consist, according to Berzelius, of

Phosphate of potash . .	27.38
——— — soda . . .	22.12
Water	50.50

100 parts of the double Arseniate are composed, by the same authority, of

Arseniate of potash .	30.24
——— soda . .	26.65
Water	44.11

The primitive form of these two salts is an oblique prism with rhombic bases; a figure often met with, without any modification.

Of the Phosphate and Arseniate of Soda and Ammonia.

We obtain these double salts by mixing phosphate, or arseniate of soda, with phosphate, or arseniate of ammonia, in equal parts. The two double salts crystallize readily in their solutions (especially the arseniate) in crystals with brilliant faces. The phosphate is usually prepared by mixing muriate of ammonia with phosphate of soda; but we must then separate it, by repeated crystallization, from the adhering sal ammoniac.

In crystallizing these two salts, a portion of the ammonia is apt to fly off, and an acid salt is formed. For this reason we ought always to add a little ammonia, if we re-dissolve the crystals to crystallize them anew. These double salts comport themselves with muriate of barytes, and the other solutions of metallic oxides, like neutral arseniates and phosphates. When heated, they lose only their ammonia and water, but no acid; and if what remains be heated along with carbonate of soda, the quantity of carbonic acid disengaged is equal to what the same weight of acid salt would have expelled.

100 parts of the ignited salts were found, by experiment, to have been combined with 75.56 of water and ammonia. According to Berzelius, the double phosphate consists in 100 parts of

of	Phosphate of soda . .	31.95
	——— ammonia .	25.19
	Water	42.86

The primitive form of these two double salts is an oblique prism, with rhombic bases, usually modified by truncations on two edges of the prism.

Of the Neutral Arseniate and Phosphate of Lead.

These two salts fuse readily before the blow-pipe, and crystallize on cooling; a character which distinguishes them from the subsalts. They contain no water of crystallization. The oxygen of the base being to the oxygen of the acid as $1:2\frac{1}{2}$, according to Berzelius, they are composed;

The Arseniate of	Arsenic acid . .	34.06
	Oxide of lead . .	65.94
The Phosphate of	Phosphoric acid .	24.24
	Oxide of lead .	75.76

The analyses of different crystallized *mixtures* of the phosphate and arseniate of lead agree with the result of some trials quoted in Mr. M.'s first memoir, viz., that bodies which have the same crystalline form crystallize together, in every possible proportion. The crystalline form of the arseniate of lead, he finds to be identical, even in its modifications, with the phosphate of lead, as described by M. Haüy, (Traité de Minéralogie iii. 490).

Of the Bi-phosphate and Bin-arseniate of Soda.

We obtain this bi-phosphate or bin-arseniate by adding phosphoric or arsenic acid to a solution of the *neutral* salts, till the liquid no longer affords a precipitate with muriate of barytes. These two salts are very soluble in water; and hence will crystallize only from very concentrated solutions, which must be left a long time in repose, when they yield large crystals. The solutions of these salts comport themselves in the same manner with solutions of metallic oxides, as the other bi-phosphates and bin-arseniates. According to Berzelius's atomic determination, 100 parts of dry bin-arseniate of soda consist of

Arsenic acid . .	78.66
Soda	21.34

And these, by our author's trials, combine in the hydrated crystals, with 24.58 of water; or it ultimately is composed of

Arsenic acid . . .	63.16
Soda	17.13
Water	19.71

The bi-phosphate consists, by Berzelius, of

Phosphoric acid . .	69.54
Soda . . . . . , .	30.46

which, in the crystallized hydrate, unite with 35.57 of water—a quantity which Mr. M. considers as containing 4 times as much oxygen as the soda does. By Berzelius, this salt is composed in 100 parts of

Phosphoric acid .	51.49
Soda	22.56
Water	25.55

It hence follows, incontestably, that this bin-arseniate and bi-phosphate of soda are in the same degree of saturation, and combined with the same quantity of water of crystallization: but their crystalline forms, as to their number, relative situation of their planes, and value of the angles, are entirely different and irreconcileable. He hence infers that the very same substance, composed of the same elements, combined in the same proportions, may affect two different forms, provided that peculiar circumstances exercise an influence in the act of crystallization. If the relative position of the atoms which constitute a crystal is changed by any circumstance whatever, the primitive form will not continue the same*. The chemical and crystallographical researches relative to arragonite, which have so much occupied the chemists and philosophers of our day, have finally shown that arragonite and carbonate of lime contain the same substances combined in the same proportions, and that notwithstanding their form is absolutely different. He enters into some details to prove that the relation between arragonite, carbonate of lead and carbonate of strontian is the same as the relation between

* Is not this mysterious modification of the theory fatal to its physical value?

carbonate of lime, dolomite, and brownspar; or the same as the relation between the arseniate and phosphate of ammonia.

Mr. M. proposes to demonstrate more completely in an approaching memoir, the law for the relation between the chemical composition and crystalline form, which may be thus stated: *The same number of atoms combined in the same manner produces the same crystalline form; and the same crystalline form is independent of the chemical nature of the atoms, being determined only by their number and relative position.*

Bin-arseniate or Bi-phosphate of Potash.

Fig. 1.

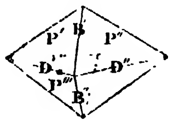
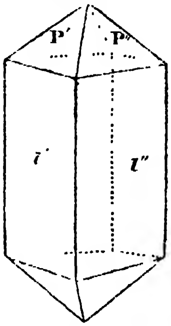


Fig. 2.



Arseniate or Phosphate of Ammonia.

Fig. 3.

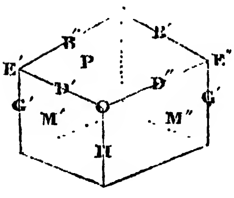
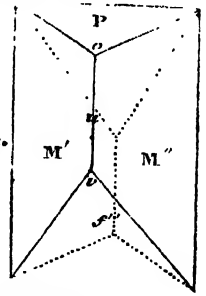


Fig. 4.



Arseniate or Phosphate of Soda.

Fig. 5.

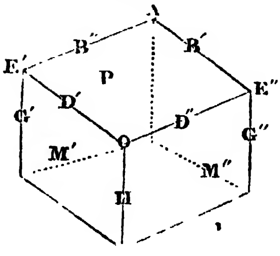
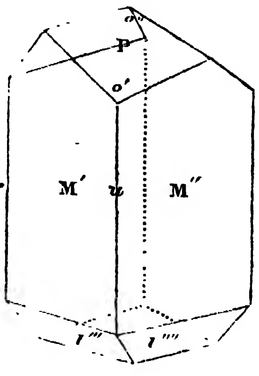


Fig. 6.



On the Composition of Alkaline Sulphurets, by M. Berzelius.

(Concluded from page 216.)

IV. *Formation of Hepar by the Humid Way.*

Hepar may be made either by boiling hydrosulphuret of potash with sulphur, or by boiling (or fusing) hydrate of potash at a moderate heat, with sulphur. When we digest a strong aqueous solution of sulphuret of potassium at a *minimum* with sulphur in powder it dissolves it, and we obtain by this means sulphuret of potassium at every degree, till the solution contains 4 atoms of hydrogen and 10 atoms of sulphur for 1 atom of potash. The same combination as this is formed when sulphuret of potassium at a *maximum* is dissolved in water.

2. When the neutral hydro-sulphuret of potash in concentrated solution is mixed with sulphur in powder, there results a strong effervescence, even at the ordinary temperature. Sulphuretted hydrogen gas is disengaged, the sulphur is dissolved, and the liquid assumes an orange colour. If we continue to add sulphur as long as the disengagement of gas takes place, we finish by obtaining a combination similar to that above described, where 4 atoms of hydrogen and 10 of sulphur are associated with 1 of potash.

3. Sulphur put to digest with hydrate of potash dissolves in it; one portion of the sulphur is acidified in the lowest degree, and forms hypo-sulphurous acid.

Observations made long since have shown that lime cannot be combined, in the dry way, with a great quantity of sulphur. I have proved that when lime is reduced by sulphuretted hydrogen, there is formed a bi-sulphuret of calcium.

In general, by the humid way, we can prepare only two determinate combinations, one with 10 atoms of sulphur, and the other with 4. The last is obtained by boiling the earth in water along with sulphur, and letting the solution cool. This combination then crystallizes.

M. Berzelius infers from his experiments, that sulphur cannot combine with an oxidized body, and that consequently no sulphuretted alkalis exist. When a salifiable base takes sulphur in the dry way, its reduction is partially effected, and there is formed a sulphate, and a metallic sulphuret. In the humid way, either the same reduction takes place, or the water is decomposed, and a part of the base combines with a compound of sulphur and hydrogen; whilst the other part unites with the hyposulphurous acid, which is generated at the same time.

V. *Of the Combinations of the metallic Sulphurets with the Alkalis.*

It is known that the sulphurets of lead, silver, copper, iron, manganese, &c., are insoluble in the alkalis; while those of arsenic,

tin, and gold, dissolve in them, as well as those of tungsten, molybdenum, and antimony. Acids separate the sulphurets unchanged. M. Berzelius regards *kermes mineral* as a tri-sulphuret of antimony, prepared in the humid way. The golden sulphuret contains more sulphur. The true proportions for preparing the former compound, he conceives to be 1 part of carbonate of potash, with 2⅜ of sulphuret of antimony. The addition of a little sulphur employed by some persons, contributes merely to augment the product of the *sulphur auratum*, and to lessen that of the kermes. He had formerly found that sulphuret of carbon is absorbed by incandescent lime and barytes, with the phenomena of ignition, and he believed that there was formed a carbo-sulphuret of lime. He thinks it now clear that it is a mixture of 1 atom of carbonate of lime, with two atoms of sulphuret of calcium.

M. Berzelius treats, briefly, in his 6th section, of the combination of selenium and tellurium with potash, for which, being an object of less general interest, we must refer to the memoir itself *.

On a new Compound of Iodine, Hydrogen, and Carbon. By M. Serullas †.

To prepare this compound, we dissolve to saturation, iodine in alcohol of at least 39°. This solution being introduced into a large test tube, we throw into it potassium in portions. After the disappearance of each fragment, we must agitate; and when the discoloration is almost complete, we must cease to add potassium, because it might act on the new compound, as soon as it could find no more iodine. On diluting the liquid with water, it becomes instantly turbid, and thickish; abundant yellowish flocks come to the surface, others fall down. This yellow matter is the hydriodide of carbon. After having separated it by the filter, it must be washed in cold water; and if we wish to have it crystallized, we re-dissolve it in alcohol, and let the solution evaporate spontaneously in wide vessels. But during this operation, the liquid becomes strongly coloured; and a certain quantity of the hydriodide is decomposed. The formation of this compound is not accompanied with any disengagement of gas, and the potassium seldom takes fire at the surface of the alcohol. Iodide of potassium is also formed at the same time, which is separated from the, hydriodide of carbon, by means of the water.

This new compound presents itself in small pearly scales, (spangles,) of a sulphur-yellow. It is friable and soft to the touch; rubbed between the fingers, it diffuses an aromatic odour; it has no decided taste in the solid state, but dissolved in alcohol, it has one manifestly saccharine. A very slight ele-

* *Annales de Chim. et de Phys.*, xx., 245. † *Ibid*, page 163.

vation of temperature decomposes it, for the heat which altered in no respect a card on which it was placed, was sufficient to effect this decomposition—manifested by the volatilization of iodine, and the deposition of charcoal. This result establishes a difference between this new compound and that discovered by Mr. Faraday, which could be volatilized without alteration, and which was decomposed only at a high temperature.

Water dissolves very little of it; it is, on the contrary, very soluble in alkohol, from which it is precipitated by water. Being heated at a spirit of wine flame, in a bell, over mercury, red iodide of this metal was formed, carbon was set at liberty, and a gas was disengaged; but the experiment having been made on a very small scale, enough of gas was not obtained for examination.

The new compound may also be obtained by putting the alloy of potassium and antimony into the concentrated alcohol; were this liquor too watery, there would be formed only iodide of potassium.

The Editors of the *Annales* state, in a note, that M. Serullas has transmitted to them several specimens of the new compound which he has discovered. Its existence, as a peculiar body, is incontestable; but it remains to know its elements more correctly.

On a peculiar Acid which is formed when we combine Cyanogen with the Alkalis. By Mr. F. Woehler, of Heidelberg*.

He passed cyanogen into water of barytes, at the bottom of which there lay some crystals of hydrate of the earth. The water was at first coloured yellow, and then brown, while there fell down an azotized carbon of the same colour, and the crystals at the bottom dissolved. The liquid had not the smell of cyanogen, but that of hydrocyanic acid. To separate the hydrocyanate of barytes, he transmitted through it a stream of carbonic acid, and after having separated the carbonate of barytes by the filter, he boiled the liquid to expel the hydrocyanic acid. But there was still produced carbonate of barytes, coloured brown by the azotized carbon. By evaporation he obtained a white salt, in small silky needles; but which was soiled by azotized carbon, and some carbonate of barytes, which were deposited during the evaporation. These two compounds formed anew, when in the intention of purifying the salt, he re-dissolved it, to make it crystallize. We shall shew the reason of this presently.

The solution of the salt thus obtained, which is always more or less coloured by azotized carbon, does not afford a blue with the solutions of iron.

* *Annalen der Physik*, T. 81. p. 95.

Sulphuric acid dropped into it produces sulphate of barytes, and the powerful acids develope immediately in it a very lively odour, resembling that of the pure acetic acid. He wished to know if the body which was thus rendered sensible to the smell by means of acids, would become manifest also with other bases. He, consequently, mixed the solution of the barytic salt with sulphate of potash, in the proportion for precipitating all the barytes, and he obtained, by evaporating the liquid, long needles, which were powerfully coloured by azotized carbon, and which yielded, with the acids, the odour above described. Similar results were obtained with salts of soda and ammonia.

The barytic salt precipitates in a white powder the nitrates of mercury, silver, and lead; the nitrate of copper, in a greenish brown; and the chloride of gold, in a brownish yellow. It does not precipitate the chlorides or perchlorides of iron and tin, nor the perchloride of mercury.

There is, then, evidently produced, when water of barytes absorbs cyanogen, a peculiar body, which saturates the bases as an acid; and it appears, in fact, that cyanogen comports itself like chlorine with alkaline solutions; that the water is decomposed, and that there is produced a hydrocyanate and a cyanate. For the sake of simplicity, he distinguishes by the name of *cyanic acid*, the body which he has obtained combined with barytes.

Every time that we evaporate the solution of an alkaline cyanate, there is formed carbonate of ammonia; which is the reason why the cyanate of barytes is always mingled with carbonate, and why carbonate of ammonia sublimes when we heat an insoluble cyanate imperfectly dried.

The Editors of the *Annales de Chimie,* after giving the author's memoir, observe, in a note, that his experiments leave the existence of the cyanic acid undecided; and one might ask him, why, after having recognised so penetrating an odour of vinegar, when he poured an acid on his pretended cyanate, he did not seek to collect the body which produced this smell. It would, perhaps, be possible, in operating at a very low temperature, and in decomposing the salt of barytes by sulphuric acid, in another solvent than water, to obtain the new acid insulated.

On a new Acid produced by the Distillation of Citric Acid. By J. L. Lassaigne*.

When citric acid is put to distil in a retort, it begins at first by melting; the water of crystallization separates almost entirely from it by a continuance of the fusion, then it assumes a yellowish tint, which gradually deepens. At the same time there is disengaged a white vapour which goes over, to be condensed

* *Journ. de Pharmacie*, Oct. 1822.

in the receiver. Towards the end of the calcination a brownish vapour is seen to form, and there remains in the bottom of the retort a light very brilliant charcoal.

The product contained in the receiver consists of two different liquids. One, of an amber-yellow colour, and an oily aspect, occupies the lower part; another, colourless and liquid like water, of a very decided acid taste, floats above. After separating them from one another, we perceive that the first has a very strong bituminous odour, and an acid and acrid taste; that it reddens powerfully the tincture of litmus, but that it may be deprived almost entirely of that acidity by agitation with water, in which it divides itself into globules, which soon fall to the bottom of the vessel, and are not long in uniting into one mass, in the manner of oils heavier than water.

In this state it possesses some of the properties of these substances; it is soluble in alcohol, ether, and the caustic alkalis. However, it does not long continue thus; it becomes acid, and sometimes even it is observed to deposit, at the end of some days, white crystals, which have a very strong acidity; if we then agitate it anew with water, it dissolves in a great measure, and abandons a yellow or brownish pitchy matter, of a very obvious empyreumatic smell, and which has much analogy with the oil obtained in the distillation of other vegetable matters. The same effect takes place when we keep it under water; it diminishes gradually in volume, the water acquires a sour taste, and a thick oil remains at the bottom of the vessel.

This liquid may be regarded as a combination (of little permanence indeed) of the peculiar acid with the oil formed in similar circumstances.

As to the liquid and colourless portion which floated over this oil, it was ascertained to contain no citric acid *carried over*, nor acetic acid; first, because on saturating it with carbonate of lime, a soluble calcareous salt was obtained; and, secondly, because this salt, treated with sulphuric acid, evolved no odour of acetic acid.

From this calcareous salt the lime was separated by oxalic acid; or the salt itself was decomposed with acetate of lead, and the precipitate treated with sulphuretted hydrogen. By these two processes, this new acid was separated in a state of purity.

Properties of the Pyro-citric Acid.

This acid is white, inodorous, of a strongly acid taste. It is difficult to make it crystallize in a regular manner, but it is usually presented in a white mass, formed by the interlacement of very fine small needles. Projected on a hot body it melts, is converted into white very pungent vapours, and leaves some traces of carbon. When heated in a retort, it affords an oily-looking acid, and yellowish liquid, and is partially decomposed.

It is very soluble in water and in alcohol; water at the temperature of 10° C. (50° F.) dissolves one third of its weight. The watery solution has a strongly acid taste, it does not precipitate lime or barytes water, nor the greater part of metallic solutions, with the exception of acetate of lead, and protonitrate of mercury. With the oxides it forms salts possessing properties different from the citrates.

The pyrocitrate of potash crystallizes in small needles, which are white, and unalterable in the air. It dissolves in about 4 parts of water. Its solution gives no precipitate with the nitrate of silver, or of barytes; whilst that of the citrate of barytes forms precipitates with these salts.

The pyrocitrate of lime directly formed, exhibits a white crystalline mass, composed of needles, opposed to each other, in a ramification form. This salt has a sharp taste. It dissolves in 25 parts of water at 50° Fahr. It contains 30 *per cent.* of water of crystallization; and is composed, in its dry state, of

Pyrocitric acid	34
Lime	66

The solution of the pyrocitric acid saturated with barytes water, lets fall, at the end of some hours, a very white crystalline powder, which is pyrocitrate of barytes. This salt is soluble in 150 parts of cold water, and in 50 of boiling water. Two grammes of this salt decomposed by sulphuric acid, furnished 1.7 of sulphate of barytes, which gives for its composition,

Pyrocitric acid	43.9
Barytes	56.1

The pyrocitrate of lead is easily obtained by pouring pyrocitrate of potash into a solution of acetate of lead. The pyrocitrate of lead presents itself under the form of a white gelatinous semitransparent mass, which becomes dry in the air, shrinking like gelatinous alumina, to which, in its physical characters, it has much analogy. It contains 8 per cent. of water, and is formed of

Pyrocitric acid	33.4
Protoxide of lead	66.6

Knowing the composition of pyrocitrate of lead, it was employed, by ignition with oxide of copper, to determine that of the acid itself, which is stated as being

Carbon	47.5
Oxygen	43.5
Hydrogen	9.0
	100.0

The proportion of the elements of this acid is very different then from that which M. M. Gay Lussac, Thenard, and Berzelius have found for citric acid. But what is remarkable, says M. Lassaigne, its capacity for saturation is nearly the same as that of citric acid, as we may see by casting our eyes on the analyses of the pyrocitrates of lime, barytes, and lead, which we have given, and which we have convinced ourselves of by frequent verification. Nevertheless, in the combinations of this new acid, the ratio of the oxygen of the oxide, tothe oxygen of the acid, is in a different proportion from that admitted for the neutral citrates; we observe that in the pyrocitrates the oxygen of the base is to that of the acid as 1 to 3.07; whilst in the citrates it is as 1 to 4.916.

The author seems here to have miscalculated strangely. Taking his analysis of pyrocitrate of lime and of pyrocitric acid, we have

34 acid, which contain 14.6 of oxygen,
66 lime . . . . 18.6 of oxygen;

so that the oxygen of the base is to that of the acid as 1 to 0.785, instead of 1 to 3.07.

In fact, the pyrocitrate of lime result makes the atom of acid referred to Dr. Wollaston's scale to be 18.3; that for pyrocitrate of barytes, makes it 76.5, and that for pyrocitrate of lead, 70. The only supposition we can form is, that the numbers for the calcareous salt are inverted in the *Journal de Pharmacie*; and that they ought to be,

Pyrocitric acid 66
Lime 34

In this case the atom comes out 69.0; a good enough accordance with the above. Were the equivalent of the acid 66.25, then it might consist of

Carbon	4 atoms . .	= 30.00	45.27
Oxygen	3	= 30.00	45.27
Hydrogen	5	= 6.25	9.46
		66.25	100.00

Experiments on the Combination of Acetic Acid and Alkohol with the Volatile Oils. By M. Vauquelin*.

First experiment: 80 measures of volatile oil of lavender were mixed with 80 measures of acetic acid, marking 10° of the areometre (1.072). After a brisk and long agitation, to effect the mixture of the two liquids, they were left in repose.

* *Annales de Chimie et de Phys.*, xix., 289.

A separation took place; the oil occupied then 125 measures, and the acid no more than 35 measures. The latter had consequently diminished by 45 measures, and the oil had acquired 45 measures. Second experiment:—80 measures of the same oil were put to the remaining 35 measures of acetic acid, and after the mixture and separation, the oil occupied 115* measures, and the acid was reduced to 5 measures. Thus, this time, the 80 measures of oil had absorbed only 30 measures of acid.

M. Vauquelin conceives, that if the oil has absorbed, this time, only 30 measures of acid, instead of 45, this depends probably on the acid having become more watery, and thereby less fit for uniting with the oil. Hence 100 parts of the acetic acid employed for this experiment contain 6 parts which cannot combine with the oil. This residuum of acid had contracted a yellow colour; its taste was still very acid, and its smell indicated that it contained much oil. In reality, when a drop of this acid was put in water, it was seen to fall to the bottom, and the oil separated from it and mounted to the surface. In this experiment, the acetic acid and oil have formed two compounds unequal in their proportions; one, where there is much oil, and which floats above: another, where there is much acid and less oil. It appears, also, that 100 parts of oil of lavender can absorb 56 parts of acetic acid; but as the portion of acetic acid which remains, holds in solution a certain quantity of oil difficult to estimate, we may admit that 50 parts of the acid are required to saturate 100 of oil; that is, 1 volume of acid and 2 of oil.

Third experiment.—To learn if water could separate the acetic acid from the oil, 50 parts of the combination richest in oil were taken, and 55 of water; they were agitated powerfully and long together; after the separation, the volume of oil was found reduced to 35, and that of the water augmented by 15 measures; yet the oil was still acid. In fact, it contained 3 parts of acetic acid. 20 parts of the same combination, being agitated with 80 measures of water, the oil after repose had lost 8, and the water had increased by the same quantity. In this experiment, the water had removed from the oil the whole of the acid which it contained, and had taken up a little of the oil itself, since the 20 parts of the combination contained 7.2 of acid, and since the oil had lost 8.

When the acetic acid is pure, the oil absorbs it entirely; but if it contain a certain quantity of water, were it only 5 per cent., there remains a portion which the oil cannot lay hold of; so that the portion of acetic acid which does not combine with the oil, contains necessarily a greater proportion of water, than it did before the operation.

* It ought to be 110.

Effects nearly similar take place, when camphire is dissolved in nitric or even in acetic acid; that is to say, the camphire takes possession of the pure part of the acids, and leaves another portion of them with the water.

Experiments on the Combinations of Alcohol with Oil of Turpentine.

1. 100 parts, in volume, of volatile oil of turpentine, and 20 parts of alcohol, mingled together, are not separable by repose, but form a homogeneous body. This effect is produced by a solution of the alcohol in the oil; for 1 part of alcohol cannot dissolve 5 parts of oil.

2. The above mixture, long and repeatedly agitated with water, was reduced to 108. The water thus deprived the oil of 12 parts of alcohol, and the oil retained 8, notwithstanding the long agitation which it experienced with the water. Oil of turpentine may therefore contain 1-12th of its volume of alcohol, without our being able to perceive it, if it be not by the specific gravity, which is a little diminished. However, if we repeat the lotions several times, we succeed eventually in removing all the alcohol from the oil. The mixture or combination of 100 parts of oil of turpentine and of 20 parts of alcohol does not become turbid by water; but when it is put over water, and slightly agitated, 1 portion of the alcohol is seen to separate, and to form, in uniting to the water, very perceptible *striæ.*

PHYSIOLOGY.

Analysis of the Memoir of M. Flourens, *entitled Physical Researches on the Properties and Functions of the nervous System, in the different vertebrated Animals**.

This Memoir is very interesting. It is composed of two parts; the first has for its object the determination of the properties of the nervous system; the second, the determination of the part which the different portions of this system perform in the voluntary movements.

According to M. Flourens, there are two properties essentially distinct in the nervous system; the one to excite muscular contraction, the other to perceive impressions. The object was to determine experimentally what parts of this system serve exclusively for sensation; and what on the contrary serve exclusively for contraction.

It is evident, that the trial of each part could alone ascertain its property. M. Flourens has therefore subjected to trial, separately and in turn, the nerves, the spinal marrow, the medulla

* *Ann. de Chim. et Phys.*, xx. 299.

oblongata, the tubercula quadrigemina, the cerebellum, and the cerebral lobes. From these experiments, thus chalked out, it follows:—

1st. That the nerves, the spinal marrow, the medulla oblongata, and the tubercula quadrigemina, are capable of exciting muscular contractions.

2d. That the cerebral lobes, and the cerebellum are not capable of exciting them. Haller and Zinn had formerly noted the impassibility (insensibility) of the upper layers of the cerebral lobes; Lorry, that of the corpus callosum; M. Flourens, has, for the first time, observed this insensibility in the whole of these lobes, in the cerebellum; and has been the first to fix the limit at the tubercula quadrigemina.

The irritation of a nerve, separated from the nervous centres by section or ligature, is confined to the excitement of abrupt and partial contractions in the muscles to which this nerve is distributed. The nerve, therefore, excites properly only contractions.

The spinal marrow being cut successively above the posterior enlargement, above the anterior, and near to the occiput: at first the animal lost the use of its hind paws, then of its fore paws, and next of the trunk; but in all these cases, all these parts, the hind and fore paws, as well as the trunk, preserve their collective movements, *(mouvemens d'ensemble.)*

We ought to add that these movements take place only in consequence of external irritations. What has disappeared, is first, the co-ordination (consentaneity) of the movements in leaping, flying, walking, standing, catching, *&c.;* and, secondly, the volition of these movements.

What remain, are the contractions and the connexion of these contractions in associated movements. The spinal marrow, then, properly ties the muscular contractions, in associations (*mouvemens d'ensemble*) as to volition and the co-ordination of these movements that resides elsewhere.

The irritation of the spinal marrow constantly occasions violent convulsions; its destruction speedily brings on death; but this last effect depends on its action on the involuntary movements. Constantly, the abstraction of one of the tubercula quadrigemina, causes the sight of the opposite eye to be lost. The irritation of a tuberculum determines contractions in the opposite iris; its complete removal abolishes the contractions completely. In the tubercula, therefore, the primary principle of the action of the iris and of the retina resides.

In proportion as we cut off the cerebellum, by successive layers, the animal loses gradually the faculty of flying or running; then that of walking, and finally that of standing upright.

A single cerebral lobe being removed, the animal loses immediately the sight of the opposite eye; but the contractility of the

iris of this eye continues, notwithstanding the animal experiences at first a weakness much more marked on the opposite side of the body. In other respects, it goes on as usual. The two lobes being removed, there is no longer any vestige of volition, or of memory, or of any perception; memory, volition, perception, reside then in the cerebral lobes.

Experiment 1st. M. Flourens removed the cerebellum in successive layers from a pigeon; at the taking away of the first slice, the animal experienced but little weakness and hesitation in its motions. At the middle layers, its walk became unsteady and agitated, altogether like that of a drunken person; soon it could not walk without the assistance of its wings. The sections being continued, the animal lost altogether the faculty of walking; its feet were no longer sufficient to support it, and it had to sustain itself on its tail and its wings; it often attempted to walk or fly, but always without success. If it was pushed forward, it tumbled over its head; if backwards, it rolled on its tail. The sections were carried farther; the animal then lost the faculty of keeping itself up on its wings and its tail; it tumbled continually, without being able to stop in any fixed position, or it finally rested flat on its back or belly. In other respects, it saw and heard very well; its air was lively, its head erect, and spirited.

Experiment 2d. M. Flourens removed from a pigeon the right cerebral lobe; the animal lost instantly the sight of the left eye; but the contractility of the iris of that eye continued unchanged. There was also a marked feebleness in the right side of its body. With the exception of these two circumstances, the animal was well; it sustained itself, walked, ran, flew, saw with the other eye, understood, wished, felt as usual. The other lobe being removed, the sight of both eyes was instantly lost, but not the contractility of the iris. There was at first a very distinct general debility. Otherwise, the animal held itself perfectly upright on its feet; and in whatever position they put it, it maintained its equilibrium. It walked, when pushed; it flew, when tossed into the air: but left to itself, it remained plunged as it were in a continual stupor. It never moved, except in proportion as it was irritated; it gave no sign of volition. Memory, vision, hearing, will; all its perceptions were extinguished. There is none of his numerous experiments which M. Flourens has not repeated on each of the four classes of vertebrated animals; and he has always indicated the shades of greater or less depth, which characterize these classes.

Since the nervous parts, from which sensation is derived, are distinct from the parts from which movement flows, we may conceive the possibility of determining at pleasure distinct palsies of feeling and motion. The most striking example of this real insulation, is that of the wonderful coincidence of the loss of

vision, with the preservation of the contractility of the iris. There are two means of destroying vision, without departing from the cerebral mass; one, the removal of the cerebral lobes, which causes the loss of sensation in the eyes; another, the removal of the *tubercula quadrigemina* which occasions the loss of motion. Finally, the cerebral lobes being removed, the animal cannot commence any motion; but if a motion be begun, it continues. It does not walk spontaneously, but it walks if pushed. It is no longer volition which determines its movements; but an external irritation may supply its absence, and determine them like volition.

Art. XVII.—MISCELLANEOUS INTELLIGENCE.

Mechanical Science.

1. *Addition to a Memoir on the Theory of Elastic Fluids, by M. de Laplace.*—This theory is founded on the principle, that each molecule of a body is submitted to the actions of three forces: 1. The attraction of the surrounding molecules. 2. The attraction of the caloric of the same molecules. 3. The repulsion of its caloric by the caloric of these molecules. The two first forces tend to make the particles approach each other; and the third tends to separate them. The three states *solid, fluid, gaseous,* depend on the respective predominance of these forces. In the *solid* state the first force is greatest: the influence of the figure of the molecules is very considerable, and they are united in the direction of their greatest attraction. Increase of caloric diminishes this influence, by dilating the body; and, when this increase becomes such that this influence is very little or nothing, the second force predominates, and the body takes the liquid state. The internal molecules are then moveable among themselves, but their attraction by the caloric of the surrounding molecules retains the whole in the same space, with the exception of the molecules at the surface, which the caloric raises in the form of vapours, until the pressure of these vapours arrests the effect. Finally, when by an increase of caloric the third force overcomes the two others, all the molecules of the liquid, at the interior as well as at the surface, separate from each other, and the liquid assumes rapidly a considerable volume, and would be dissipated in vapours, if not strongly retained by the surface of the vase or tube containing it. It is to this state of very compressed gas that M. Cagnard-Latour has reduced ether, alcohol and water, in the curious experiments lately communicated to the Academy of Sciences. In this state the two first forces are still sensible; but, if by a diminution of pres-

sure this compressed gas assumes such a volume that its density shall be of the same order or kind as that of the atmosphere, then the two first forces become insensible: the molecules are no longer sensibly subject except to the repulsive force of their caloric, and are obedient to the laws of Mariote and Gay-Lussac, from which they depart in the very compressed state, as results from the experiments cited. In pursuing by similar but precise experiments the ratio between the pressure, the temperature, and the volume, it would be seen how they approached more and more to the general laws of aëriform fluids.—*Annal. de Chimie*, xxi. 22.

2. *Mathematical Prize Question.*—The following has been proposed by the class of mathematics of the Royal Academy of Sciences of Prussia: "To give a complete mathematical theory of the luminous or coloured circles which form around the sun and moon, and such an one as will equally agree with the results of observations, and with the known properties of light and the atmosphere."

This question was proposed for 1822, but is extended to 1824. The possible influence of the inflection and polarization of light is to be considered. Memoirs are to be sent in before the end of March 1824. The prize is 50 ducats.

3. *Survey of the Heavens.*—The indefatigable Bessel has commenced an important work, which every lover of astronomy must wish to see followed up with success. It is a general survey of the heavens in zones: and the first part of the work is already in the press.

4. *Improvement in Metallic Casting.*—Iron and metallic castings are said to be very much improved, by subjecting the metal, when in the moulds, to pressure. This is done by making a part of the mould of such a form as to receive a piston, which, on the metal being introduced, is made to press on it with any required force. It is stated that castings obtained in this way are not only free from the imperfections generally incurred in the usual mode, but have a peculiar soundness of surface and closeness of texture, qualities of the utmost importance in ordnance, rolling cylinders, &c. The improvement belongs to Mr. Hollingrake, who has obtained a patent for it.

5. *Canal Navigation.*—The tread-wheel has been applied by M. Van Heythuysen to the propelling of barges on canals. The object is to obviate the use of horses. The apparatus is made light and separable from the barge, and it is found that two men can propel a barge by it, at the rate of five miles per hour. The saving of the expense of horses and track-roads promises to make this application of human power very valuable.

6. *New Lithographic Press.*—Messrs. Taylor and Martineau, engineers, have, in consequence of the extension and importance of lithographic printing, been induced to construct a new press, which appears to combine every necessary qualification. It is simple, powerful, accurate, and cheap. Several errors which existed in the old presses are corrected in it.

7. *New Mode of printing Designs.*—A discovery has been made in the department of Calvados in France, by which the finest strokes of the crayon, or pencil, upon porcelain, may be infinitely multiplied. These strokes, traced with a particular metallic composition upon the polished surface of porcelain, are incrusted by the second application of fire, without the slightest injury. The parts thus delineated acquire a sort of roughness, insensible to the touch, and only to be discovered by its perfect retention of ink, which is easily wiped off the other parts of the surface. This method seems to have decided advantages over lithography.

We can guess at the nature of the above invention, but the description, which is from the *European Magazine*, is too imperfect to admit of a probable estimate of its value.

8. *Artificial Slates.*—A species of artificial slates have been used in Russia, which are said to be very valuable, as being lighter than common slates, impermeable to water, incombustible, and made of any required form or size. They have been analyzed by M. Giorgi, who finds them to consist of bolar earth, chalk or carbonate of lime, strong glue, paper pulp, and linseed oil. The earthy materials are to be pounded and sifted; the glue dissolved in water; the paper is the common paper pulp, which, after being steeped in water, has been pressed, or it may be bookbinders or stationers' shavings boiled in water and pressed. The linseed oil is to be raw. The paper pulp is to be mixed in a mortar with the dissolved glue, the earthy materials then added and beaten up, and the oil added during the beating as fast as it is absorbed. The mixture is then spread with a trowel on a plank, on which a sheet of paper has been laid, and surrounded by a ledge, to determine the thickness of the layer, and is then turned out on a plank strewed with sand to dry. When dry they are passed through a rolling mill, then pressed, and finally finished by a coat of drying oil.

The following are some of the various proportions recommended:

2 parts paper pulp, 1 glue, 1 chalk, 2 bole earth, 1 linseed oil; this forms a thin, hard, and very smooth sheet.

3 parts paper pulp, 4 glue, 4 white bole earth, and 4 chalk, oil ? produce an uniform sheet, as hard as iron

1 paper pulp, 1 glue, 3 white bole earth, 1 linseed oil; a beautiful elastic sheet.

When these plates or slates were steeped in water for four months they were found not to alter at all in weight; and when exposed to a violent heat for five minutes, they were hardly altered in form, and were converted into black and very hard plates.—*Tech. Rep.* ii. 421.

9. *Damp Walls.*—The following method is recommended to prevent the effect of damp walls upon paper in rooms. Line the damp part of the wall with sheet-lead, rolled very thin, and fastened up with small copper nails. It may be immediately covered with paper. The lead is not to be thicker than that which lines tea-chests.

10. *Improvement in Trusses.*—We understand that Mr. Coles, of Thames-street, has effected a considerable improvement in the construction of trusses, by which the pressure upon the ring is not merely equalized, but which adjusts itself, without inconvenience to the wearer, to the different attitudes in which the body may be placed.

11. *Result of the Experiments made by order of the Board of Longitude, for the Determination of the Velocity of Sound in the Atmosphere. Drawn up by* M. Arago.—The observations were made by a commission, consisting of MM. Humboldt, Gay-Lussac, Bouvard, Prony, Mathieu, Arago, and Rieussec.

They have deduced from the mean of two days' experiments, on the report of cannons, measured as to their times of being heard, by excellent chronometers of M. Breguet, that at 10° C., the velocity of sound per second is 173.01 toises = 337.2 metres = 1106.32 English feet, estimating the length of the metre to be 39.37079 English inches, as determined by Captain Kater.—*Ann. de Chim. et de Phys.* xx. 211.

II. Chemical Science.

1. *On a New Class of Compounds of Sulphur. By* Dr. Zeise, of Copenhagen.—If a certain quantity of sulphuret of carbon be poured into an alcoholic solution of one of the alkalies, a neutral liquid is obtained, in consequence of the formation of a new acid, which neutralizes the alkali. If potash has been used, the salt may be obtained either by refrigeration, evaporation, or precipitation, by sulphuric ether. It contains no carbonic acid, or sulphuretted hydrogen, but an acid, which is in the same relation to sulphuret of carbon that hydrocyanic acid is to cyanogen. Its compounds have been called hydrocarbo-sulphates.

Hydrocarbosulphate of potash crystallizes in needles. It has a strong peculiar smell, is very soluble in water, soluble also in alcohol, but scarcely in ether. Sulphuric or muriatic acid, added to a concentrated aqueous solution, precipitates a yellowish oil-like liquid, of a peculiar strong smell. The salt heated to 140° is not changed, but at a high temperature, it melts, effervesces, and is resolved into carbonic acid, another gas, and an oil-like fluid, and a mixed mass is left behind, consisting of a compound of potassium and sulphuret of carbon. In the candle the salt inflames and burns with sparks.

Hydrocarbosulphate of soda crystallizes with difficulty; it deliquesces in moist air, and is not separated from alcohol by ether. With acids and metallic solutions its phenomena resemble those presented by the salt of potash.

Hydrocarbosulphate of lime may be formed by mixing a solution of muriate of lime in alcohol, with the salt of potash also in alcohol. Muriate of potash is precipitated, very little indeed remaining in solution.

When hydrocarbosulphate of potash in solution is added to solutions of certain metals, precipitates are formed, which Dr. Zeise considers as compounds of the metal with a sulphuret of carbon, no oxygen or hydrogen being present, with the exception, perhaps, of the compound of zinc. Carbosulphuret of copper, made from the nitrate or sulphate, is yellow. Carbosulphuret of lead, from the nitrate, is white, foliated, and shining. Carbosulphuret of mercury, from corrosive sublimate, or prussiate of mercury, is white and granular. The compounds of lead and mercury are soluble in alcohol. Strong acids act very slowly on these bodies. At a heat below 212° they are not injured, at a higher temperature a mist appears condensing into a yellow oily liquid, smelling of onions, then the substance melts; a gas is given out in great quantity, which appears to be a new compound of sulphur and carbon. The substance passes through various shades of colour, and at last exhibits the phenomena of combustion, becoming quite black.

The substance left ultimately is a metallic sulphuret and carbon; but if the heat be abated when the matter is only brown, another kind of carbosulphuret is produced.

Hydrocarbosulphuric acid may be procured by pouring a mixture of 4 parts sulphuric acid, and 3 of water, on the salt of potash, and in a few seconds adding abundance of water. The acid collects at the bottom of the water as a transparent, slightly-coloured oil; it must be quickly washed with water, until free from sulphuric acid.

This acid reddens litmus paper powerfully. Its odour differs from that of sulphuret of carbon. Its taste is acid and astringent. It burns readily, giving out sulphurous fumes. It is decom-

posed by heat; with the alkalies it forms the peculiar salts, and when water is present, expels carbonic acid from carbonates of potash, ammonia, and barytes. When just covered with water, and iodine added to it, decomposition takes place, sulphuret of carbon, and a solution of hydriodic acid being produced. Iodine, added to the salt of potash, produces sulphuret of carbon and hydriodate of potash.

Dr. Zeise then remarks on the probable existence of a peculiar compound of carbon and hydrogen, but mentions his intention of extending his researches on this and some other subjects, and of giving his conclusions to the world at some future time. —*Ann. Phil.* N.S. iv. 241.

2. *On a peculiar Sulphate of Alumina, by Mr. Phillips.*—Mr. Phillips obtained this salt by putting moist alumina into dilute sulphuric acid, and adding more occasionally, until it remained in excess; being now filtered, a clear dense solution was obtained, which, when dropped into water, instantly let fall a precipitate as abundant almost as that from muriate of antimony. It also immediately began to precipitate even of itself, though no tendency of this kind was observed, as long as the excess of alumina remained mixed with it. The deposition went on for several months; but the clear part was always precipitable by water. Another property of this sulphate of alumina is, that if heated to 160° or 170° Fahr., it becomes opaque and thick; but upon cooling, in a few days, becomes clear again.

From an average of experiments, 100 grains of the solution (which, however, had been depositing for some weeks) when precipitated by water in sufficient quantity, gave 5.23 grs. of subsulphate of alumina; 100 grs. of the solution on analysis gave 5.27 sulphuric acid, and 5.38 alumina; 100 grs. of the spontaneously-deposited salt gave 26.10 grs, of sulphuric acid and 26.68 alumina. Hence the salt deposited and the salt in solution appear to be the same:

Sulphuric acid	40	the first,	40	the second.
Alumina . .	40.83	——	40.92	——

Mr. Phillips considers the number 27 as representing the atom of alumina; the salt therefore will consist of 2 atoms sulphuric acid $40 \times 2 = 80$, and 3 atoms of alumina $27 \times 3 = 81$.—*Ann. Phil.* iv. 280.

3. *Effect of Cold on Magnetic Needles.*—Dr. De Sanctis has lately published some experiments on the effect of cold in destroying the magnetic power of needles *, or at least of rendering them insensible to the action of iron and other magnets,

* *Phil. Mag.* lx. 190.

Mr. Ellis has claimed the merit of this discovery, and of the reasoning upon it, for the late Governor Ellis†. Conceiving it important to establish the fact that cold, as well as heat, injured or destroyed the magnetic power of iron and steel, we wrapped a magnetic needle up in lint, dipped it in sulphuret of carbon, placed it on its pivot under the receiver of an air-pump, and rapidly exhausted: in this way a cold, below the freezing of mercury, is readily obtained. When in this state, the needle was readily affected by iron or a magnet, and the number of vibrations performed in a given time by the influence of the earth upon it were observed. A fire was now placed near the pump, and the whole warmed; and when at about 80° Fahr. the needle was again examined, it appeared to be just in the same state as before as to obedience to iron and a magnet, and the number of oscillations were very nearly the same, though a little greater. The degree of exhaustion remained uniform throughout the experiment.—Ed.

4. *Frauds committed on Bankers' Checks, &c.*—Considerable interest has lately attached to the means which may be adopted to render bankers' checks, *&c.*, secure, from the discovery that in some cases the sum had been obliterated by chemical agents, and a larger sum inserted, and there are now two or more patents for paper, intended to prevent the possibility of such a fraud. These are founded on chemical properties, and do not appear to us to be sufficiently secure; but a mode of an entirely different kind has been suggested by Dr. Paris, which at once appears simple, perfect, and in every respect unobjectionable. It consists in a new mode of notation, which is accomplished by three or more rows of figures, in inverted order, thus: 987654321, arranged in the scroll of the check, and representing units, ten, hundreds, *&c.* The drawer of the check, in removing it from his book, has only to cut between the particular figures which represent the sum drawn, and in this manner an indelible and unalterable indication is afforded. The sum may be changed to a smaller sum, but this, obviously, cannot offer any objection.

9 8 7 6 \ 5 4 3 2 1	Pay Mr.________________
9 8 7 6 5) 4 3 2 1	Five hundred and forty-five
9 8 7 6 / 5 4 3 2 1	pounds.

5. *Pyroligneous Ether.*—Mr. P. Taylor, in 1812, and at various times since then, obtained, by the distillation of wood in the large way, a peculiar inflammable volatile fluid, very much

* *Phil. Mag.* lx. 310.

resembling alcohol in its obvious properties. It was miscible with water, dissolved camphor and gum resins, burned with a flame like that of alcohol, and had a specific gravity of between 830 and 900. It differed however from alcohol, as the following experiment shewed. To a portion highly rectified, the proper proportion of sulphuric acid was added to form with alcohol, ether, and the whole was distilled; but instead of procuring ether, a spirit came over still miscible with water, and burning with a blue flame. Its smell was a little altered, and its specific gravity reduced. The residuum in the retort was a black pitchy substance, becoming perfectly hard and brittle on cooling.

Mr. Taylor has promised more information on this subject. *Phil. Mag.* lx. 315.

6. *Phosphate of Soda and Ammonia.*—M. Anatole Riffault has given the following as the composition of this salt derived from very careful analysis. It accords perfectly with the composition and views given by M. Mitscherlich in his memoir on crystalline forms.

Phosphoric acid	34.491
Soda	14.875
Ammonia	9.000
Water	41.634
	100

Or,	Neutral Phos. Soda . .	31.999—	1 atom.
	Phosp. Ammonia . . .	26.377—	1 atom.
	Water	41.634—	10 atoms.
		100	

Microcosmic salt, of which the analysis is given by Fourcroy, consists of one atom sub-phosphate of soda, one atom sub-phosphate of ammonia, and three atoms of water; so that by calcination it becomes a neutral phosphate of soda.

Sulphate of soda and ammonia consists of

Sulphate of soda	42.239—	1 atom.
Sulphate of ammonia . . .	31.729—	1 atom.
Water	26.032—	5 atoms.

Ann. de Chim. xx.

7. *On a beautiful Blue Colour.*—A portion of a very fine blue pigment was placed in the hands of M. Braconnot, by M. Noel, for examination. It was the produce of a manufacture at Schweinfurt, where the preparation was kept secret. M. Braconnot readily ascertained it to be a triple compound of arsenious acid, hydrated deutoxide of copper, and acetic acid, so that it approximates to the green of Scheele. After various

trials to form it, the following process was found to be the best. Six parts of sulphate of copper were dissolved in a small quantity of water; also, six parts of white arsenic, with eight parts of potash of commerce were boiled in water until no further quantity of carbonic acid was disengaged. This hot solution was gradually mixed with the first, continually agitating until effervescence ceased; an abundant dull yellowish green precipitate was formed. About three parts of acetic acid were then added, or such a quantity, that a slight excess was sensible to the smell; gradually the precipitate diminished in volume, and in some hours, a slightly-crystalline powder was deposited at the bottom of an entirely colourless solution. The fluid was poured off as soon as possible, and the powder, washed with plenty of boiling water to remove the last portions of arsenic, was then of a brilliant colour.

Care must be taken not to add to the cupreous solution an excess of arseniate of potash, as it causes waste of the acetic acid afterwards added, as the latter must be in excess. In repeating the process in the large way, an arsenite of potash, prepared with eight parts of oxide of arsenic, instead of six, was used, and the result was very successful. M. Braconnot thinks that probably a slight variation of the proportion he has given may be found advantageous; but in the mean time considers it right to give the best process he is able for the preparation of a colour so beautiful, and which may be very valuable in the arts.—*Ann. de Chim* xx. 53.

8. *Sugar Cane Juice.*—M. Vauquelin received some bottles from Martinique, containing the juice of the sugar-cane, it having been subjected to M. Appert's process for its preservation. In most of the bottles, however, a species of semi-transparent gum had been formed, which, when separated by alcohol purified and dried, became white, opaque, and of a slight sweet taste. This substance was very soluble in water, but formed a milky solution: it puffed up when heated, carbonized and emitted a smell like that of sugar or gum. It appeared nevertheless to contain a small portion of animal matter. By treatment with sulphuric acid it did not yield sugar; by nitric acid, it was converted into oxalic acid, and a yellow bitter matter, but no mucic acid was formed. When burnt, it left about $\frac{1}{100}$ of ash, consisting of phosphate of lime, iron and silica. M. Vauquelin concludes that this substance was formed from the sugar, and did not previously exist in it.—*Ann. de Chim.* xx. 93.

9. *Salep and Magnesia.*—Mr. Brander, of Hoxton, found that when twenty grains of salep were dissolved in four ounces of water and thirty grains of magnesia added, the whole became after some hours solid and jelly-like, and even after a month,

had not become in the least putrid. Neither albumen, tragacanth gum, jelly, nor starch, produced with magnesia the same effect. Nor does lime or white bole produce the same effect on salep. The jelly is insoluble in water, fat oils, oil of turpentine, alcohol, or caustic potash, acids partly dissolve it, the remainder being bulky and opalescent.—*Ann. Phil.* iv. 469.

10. *Affinity of Glass for Water.*—M. Gay-Lussac mentions that the affinity of glass for water is so great, that, after being dried, it abstracts from air part of its hygrometric water.

11. *On the porosity of Glass and siliceous Bodies.*—Mr. Deuchar in a paper on the occasional appearance of water in the cavities of crystals, and on the porous nature of quartz and other crystalline substances, which paper was read before the Wernerian Natural History Society, suggests that the crystals which are found to contain these portions of water were probably once hydrated, or rather, contained throughout their mass an excess of water, and that this fluid having afterwards separated from the crystals passed by capillary attraction either to the surface, or to any accidental *void* space within them.

Mr. Deuchar thinks it obvious that the water might pass through the crystals, not only from the porous nature of their particles, but also from their temporary display of rents during the application of a *high* temperature. It is supposed that all siliceous bodies, even glass, *&c.*, are porous, and the author thinks that the filling of well-stopped bottles, when sunk to great depths in the ocean, depends on the water passing through the glass, and not through the materials used to stop the bottles, though these were only cork, sealing-wax, and oil-cloth. We would, however, refer our readers to the paper itself in the *Phil. Mag.* lx. 310., but wish them at the same time to read one by Mr. Scoresby, in the *Edin. Journal,* vi. 115., also relating to sunken bottles.

12. *On the Temperature produced by Vapour, and on the Temperature of Vapour, by M. Faraday, Chem. Assistant, &c.*—I had occasion to observe, a short time since, a curious property of vapour, which, though it appears to have been known to some philosophers, had not been generally noticed, and had never, I believe, been published. It is the power it possesses of raising certain bodies to a temperature higher than its own. The fact may easily be observed, by holding a thermometer horizontally in a current of steam as it issues from the mouth of a tea-kettle or a flask, or any other vessel; and when it has attained 212°, dropping a little powdered tartrate of potash or muriate of ammonia or nitre on to it; the temperature will im-

mediately rise up to between 230° and 240°. The same effect may be observed by tying the bulb up with the substance in a piece of flannel or lint, and introducing it into an atmosphere of steam.

The substances possessing this property are those, the solutions of which require a higher temperature for their ebullition than the solvent (in this case water) does, and their power is in proportion, as would readily be anticipated, to the elevation of the boiling point of the solution. The following are the temperatures produced in this way by some substances. The first column of figures indicates the temperature obtained by the method first mentioned. The second column those by the second method:

Sulphate of Magnesia	218°	214°
Tartrate of potassa	236°	230°
Tartaric acid	226°	221°
Sugar	216°	223°
Muriate of ammonia	230°	227°
Citric acid	230°	228°
Nitre	232°	230°
Nitrate of magnesia	236°	236°
Nitrate of ammonia	236°	240°
Acetate of potash	241°	258°
Subcarbonate of potash	258°	262°
Potash	300° and upwards.	

This effect evidently depends upon the attraction of the substances for water. It enables them, when in contact with the vapour, to condense it, and the heat evolved by the condensation is that which principally raises the temperature. It is not, however, necessary to enlarge on the explanation, but I am anxious here to make my acknowledgments to M. Gay-Lussac for the correction of an error into which I had fallen. The observations, when first written, were, from circumstances, sent to Paris, and have since that been inserted in the *Annales de Chimie*. I had said incidentally, and without reference to sufficiently careful experiments, that vapour rising from a boiling aqueous solution of a salt was of the same temperature as that rising from boiling water under the same pressure. M. Gay-Lussac, remarking on this statement, stated, that the temperature of the vapour was always that of the solution from whence it rose. I have since then made various experiments on the subject, and found, (as I expected,) that philosopher correct. But I was considerably surprised by the difficulty of getting accurate results; and it was only by having a double boiler, which contained solution between its sides and at the top, as well as within, by heating the thermometer up to high points, and letting it cool in the vapour, by operating for long periods

of time, &c., that I was able to satisfy myself there was no anomaly in the phenomena.

13. *Metallic Titanium.*—Dr. Wollaston has lately discovered that the small cubic crystals of a metallic lustre and reddish colour, which are occasionally found in the cavities of the slags from iron furnaces, are pure titanium.

14. *Congelation of Mercury.*—M. Gay-Lussac states, in a memoir on the cold produced by the evaporation of fluids, that he has readily frozen mercury, by surrounding it with a frigorific mixture of ice and salt, in the apparatus in which aqueous vapour is produced and absorbed by the process of Mr. Leslie; and he has no doubt that, with analogous means and very vapourable liquids, a degree of cold might be produced below that produced by mixtures.—*Annales de Chimie*, xxi. 85.

15. *Variation of Thermometers.*—M. Flaugergues, in a letter to M. Pictet, points out an effect in certain thermometers, consisting of a gradual elevation of the freezing-point of ice. It takes place with those mercurial thermometers which, being hermetically sealed, have a perfect vacuum above the mercury. In some cases this elevation has risen to .9 of a degree, and has gone on increasing for years together. In examining into the cause of this effect, M. Flaugergues soon observed that it did not take place with mercurial thermometers open at the top, or with alcohol thermometers; and he was led to attribute it to the constant pressure of the atmosphere on the bulb of the instrument. He thinks that the glass gives way by degrees to this pressure, just as any elastic spring will do under a constant force, and this gradually produces the effect observed. M. Flaugergues thinks, therefore, it would be better to make mercurial thermometers with open terminations, introducing a small plug of cotton to keep the dirt from entering, or in some cases even closing the aperture by some elastic substances, as caoutchouc, &c.—*Bibliothèque Universelle*, xx. 117.

16. *New Electro-Magnetical Experiments. Ampere.*—Two very interesting electro-magnetic experiments have lately been made by M. Ampere, in the laboratory of M. de la Rive at Geneva. M. Ampere had been induced, from his mathematical investigations, to expect a repulsion between two portions of an electrical current passing in the same direction, and in the same right line, or that every part of an electrical current would repel the other parts, a result which may be comprehended by conceiving an endeavour in the current to elongate itself. The experiment which M. Ampere has contrived to illustrate this action of the current, and which our readers may compare with one

described, Vol. XII., page 420 of this Journal, consisted in dividing a dish into two parts by a division across the middle, and filling each division with mercury, a piece of wire was then bent into the form of the letter U, but the curved part was bent to one side, so that the two limbs of the wire might lie on the mercury one on each cell, and the bent part pass over the division without touching it. The wire was covered with silk, except a small portion at each extremity, by which the communication was established with the mercury. The poles of a voltaic apparatus were then connected with the cells of mercury near to the division, so as to be in the lines of the limbs, in which case the wire moved parallel to the division, so as to elongate the current through which the electricity was passing.

The second experiment consisted in placing a circle of copper plate in the middle of strong electrical currents, which came very near without touching it. When a strong horse-shoe magnet was brought to one side of the plate, it was sometimes drawn in between the two limbs of the magnet, and sometimes repelled according to the direction of the current and the position of the magnet. This experiment is very important, since it demonstrates that those bodies which do not acquire permanent magnetism by their vicinity to electrical current, as iron and steel do, may nevertheless receive a transient state of magnetism in the same circumstances.—*Bib. Univ.* xxi. 47.

17. *New Electro-Magnetic Experiments. Sebeck.*—The following is a very curious and simple electro-magnetic experiment made by Dr. Sebeck of Berlin. Take a bar of antimony, about eight inches long, and half an inch thick; connect its extremities by twisting a piece of brass wire round them so as to form a loop, each end of the bar having several coils of the wire. If one of the extremities be heated for a short time with a spirit lamp, electro-magnetic phenomena may be exhibited in every part of it.—*Ann. Phil.* iv. 318.

We have repeated this experiment with every success. The brass wire is in that state which would be produced by connecting its heated end with the negative pole of a voltaic battery, and its cold end with the positive pole.—Ed.

18. *Electro-Magnetic Effect of Lightning.*—A violent thunder-storm occurred on the 22d of June last, at Toulouse, when the lightning passed by various metallic pipes through a house, and gave occasion to observe its strong powers of magnetization. Just under the roof, a part of the floor was completely destroyed by the lightning, and a piece of iron that had belonged to it had become so strongly magnetic, that it was able to lift a table-knife. Small iron tools were magnetized by the iron,

but it lost its power in 36 hours. A tailor was sitting on a chair near the conductor through which the lightning passed; he felt no shock, but next day, on taking a case of needles from his pocket, he found them so strongly magnetized, that they hung six or seven together. Another case, containing five needles, was lying on a chimney-piece 20 feet from the conductor; they also were magnetized. There were fourteen or fifteen persons in the house, none of whom felt the electricity. It may be presumed, therefore, that the whole went through the conductor. In the present state of electro-magnetic science, it is easy to understand the effect on the needles and neighbouring pieces of iron. The case resembles those quoted by Sir H. Davy, from the *Phil. Trans.*, and is an illustration of the process he recommends for the formation of powerful magnets by lightning-rods.—*Ann. de Chim.*

19. *Conduction of Electricity by Amadou.*—It is remarked, in a note at the end of the June number of the *Journal de Physique*, that the effect of a piece of amadou, in drawing off electricity from charged surfaces, is equal to that of a metallic point. For this purpose, it requires to be dry; and it may be observed, that at the time a number of fibres rise up and point towards the electrified surface. For the rapid abstraction of electricity, it requires, however, that besides offering points, the body should possess a high conducting power, which was not previously known to belong to this substance.

20. *Electrical Effect.*—The following effect is attributed by Mr. Fox, who observed it, to electricity. A piece of iron pyrites was fastened with a piece of brass wire in a moss-house, the moss being damp. On the following day, the wire was found broken and excessively brittle, and in those parts in contact with the pyrites much corroded. On one occasion, after the brass wire had been fastened once or twice round a piece of iron pyrites, and had remained for some days enveloped in damp linen, the constituents of the brass wire were separated, and it was converted into copper wire coated with zinc.—*Ann. Phil.*, iv. 447.

21. *New Process for extracting Strychnine (Strychnia)*, by M. Henry.—It consists in treating, at several times, nux vomica reduced to powder, with hot water in close vessels. When the decoctions are finished, they are mixed together, and evaporated to the consistence of a thick syrup, to which powdered lime is to be added in slight excess. This forms with the igasuric acid an insoluble salt, which, mingled with the strychnia and other substances, forms a gelatinous mass. This matter must be treated with hot alcohol at 38° of the hydrometer, which dissolves the strychnia, and a little colouring matter, but

which does not act on the other substances. The action of the alcohol is repeated twice, or till it acquires no bitter taste. The sediment is subjected to the press. The alcohol is filtered, and then distilled off in a water-bath. There remains in the retort a very small quantity of a deep-coloured liquid, and a substance in the form of brilliant crystals. These are strychnia, containing a colouring and oily matter; if it be treated several times with alcohol, we obtain it very pure. It is indeed more expeditious to form an easily crystallizable salt with it, for which purpose dilute nitric acid is preferred by M. Henry. The nitrate solution, after concentration, is treated with animal charcoal at a boiling heat, and quickly filtered. On cooling, the salt forms in slightly-coloured crystals, which can be purified by solution and re-crystallization.

To obtain strychnia from this salt, we pour into its solution a slight excess of ammonia, when the vegetable alkali precipitates in a white powder. The nitrate must be dissolved in the least possible quantity of water, as the strychnia itself being somewhat soluble, a portion would be left in the liquid.

The whole strychnia may be separated from the mother waters by concentrating them, and adding anew pulverized quicklime, and then treating the mass with alcohol. One kilogramme of pulverized *nux vomica* yields from 5 to 6 grammes of strychnia.—*Jour. de Phar.*, Sept. 1822.

22. *Smalt in Sugar.*—It appears from a note in the *Journal de Pharmacie* for October last, that the Parisian refined sugar contains sometimes a notable quantity of smalt, which falls to the bottom of the vessel in which that substance is dissolved. As the cobalt ore from which smalt is made generally contains arsenic, this sophistication is justly reprobated.

23. *On the Employment of Potatoes in Steam-Engine and other Boilers, to prevent the calcareous Incrustations on their Bottoms and Sides.*—The practice of adding about 1 per cent. of potatoes to the bulk of water contained in a steam-engine boiler, which has been long practised in this country, has been recently introduced into France, and merits the encomium which is bestowed on it by M. Payen, in a letter to the Editor of the *Jour. de Phar.*, Oct. 1822. He assigns the true cause of the beneficial agency of the root. The potato dissolves in the boiling water, forming a somewhat viscid liquid, which envelopes every particle of the precipitated calcareous salt, (usually selenite, sometimes carbonate of lime,) renders them slippery, so to speak, and prevents their mutual contact and cohesion. After a month's service, the boiler is emptied, and new potatoes added along with the charge of water.

24. *On the manner of estimating the Quantity of Sulphuretted*

Hydrogen Gas in Sulphureous Mineral Waters, by M. Desfosses, of Besançon.—After pointing out the uncertainty and difficulty of the ordinary methods, he recommends the use of bin-acetate of copper, from which sulphuretted hydrogen throws down a sulphuret of copper, whose weight will indicate the quantity of sulphur; and, consequently, the quantity of sulphuretted hydrogen may be thence inferred. He gives some experimental proofs of the accuracy of this plan of analysis, and applies it to the examination of the sulphureous waters of Guillon, near Baume-les-Dames, in the department of the Doubs. He adds to the water in question a solution of bin-acetate of copper, till the mixture loses its sulphureous odour. He then collects and dries the precipitate. These waters contain, in 6 kilogrammes,

Sea-salt	1.520gr.
Carbonate of lime . . .	0.700
Carbonate of magnesia .	0.227
Insoluble residuum . .	0.020
	2.467

Gaseous products.

Free sulphuretted hydrogen . .	65 centim. cub.
Carbonic acid	100
Azote	45

Jour. de Phar., Oct. 1822.

25. *Flowers of the Common Mallow, (Malva Silvestris) an excellent Test of Alkali.*—MM. A. Payen and A. Chevalier state, that an alcoholic infusion of these flowers (previously dried by a steam heat out of contact of light) gives a sensible tinge of green on being mixed with pure water containing $\frac{1}{20000}$ part of potash, $\frac{1}{1000}$ part carbonate of soda, and $\frac{1}{25}$ of lime-water.

According to the same chemists, the colouring matter of the fruit of the *cerasus mahaleb* (wood of St. Lucie) is an excellent test of acids, but inferior in delicacy to litmus. Infusions are more sensible to change of colour than coloured paper.

26. *Method of Colouring Alum Crystals.*—In making these crystals the colouring should be added to the solution of alum in proportion to the shade which it is desired to produce.

Coke, with a piece of lead attached to it, in order to make it sink in the solution, is the best substance for a nucleus; or, if a smooth surface be used, it will be necessary to wind it round with cotton or worsted, otherwise no crystals will adhere to it.

Yellow.—Muriate of iron.

Blue.—Solution of indigo in sulphuric acid.

Pale Blue.—Equal parts of alum and blue vitriol.

Crimson.—Infusion of madder and cochineal.

Black.—Japan ink thickened with gum.

Green.—Equal parts of alum and blue vitriol with a few drops of muriate of iron.

Milk White.—A crystal of alum held over a glass containing ammonia, the vapour of which precipitates the alumina on its surface. T. G.

III. Natural History.

1. *On the Suspension of Clouds, by M. Gay-Lussac.*—Clouds are collections of aqueous vesicles, on the nature of which philosophers are not perfectly agreed. * These vesicles may be either hollow or full. In the first case, though they must certainly be more dense than the air they displace, we may conceive their suspension in this fluid, as we conceive of a heavy precipitate in water; but in the second case, we have more difficulty, in admitting that bodies ten or twelve hundred times heavier than the air they displace at the height of clouds should not precipitate towards the surface of the earth, and that the principal mass of clouds should be sustained at a height between 1500 and 2500 metres. Even in admitting that the vesicles are hollow, their suspension is not exempt from difficulty; but not wishing to enter into discussion on the causes, I will confine myself to the consideration of the principal one, and endeavour to show its importance by the ancient but curious experiment of soap bubbles.

If the thinnest soap bubble be blown in an apartment it will never rise, but descend directly it is left to its own weight, and that even when it is not blown with air from the lungs, which is a little heavier than the atmosphere from carbonic acid in it*. But if, on the contrary, the soap bubble be blown in the open air above a heated soil, it will be seen to rise a height more or less considerable, and frequently break before it has attained that to which it would have reached, if its envelope had not been dissolved and thinned by the air. It is evident from this experiment, that there rises from the surface of the earth an ascending current, which pushes the bubble before it, until weakened by its dilatation or by its mixture with colder air, its force of impulsion is in equilibrium with the weight of the soap bubble; and we may conceive from that, why the latter cannot rise in an apartment where the temperature is uniform. If the bubble were

* The bubble would descend even though the weight of the envelope could be removed, because being cooled by evaporation, the air within, notwithstanding the presence of aqueous vapour, would generally be heavier than the surrounding atmosphere.—Ed.

lighter, it would be carried higher by the current, and we may admit, without difficulty, that the aqueous vesicles, or rather the mass of air through which they are diffused, may remain suspended at a considerable height, variable according to the seasons, and greater in summer than in winter.—*Ann. de Chim.* xxi. 59.

2. *Meteors (on their nature.)*—From the incertitude at present existing with regard to those meteors known by the name of falling stars, a considerable value attaches to careful observations of the phenomena they present, especially when made by men of sound judgment and upon whom reliance can be placed. It has happened that twice lately opportunities have occurred in France for observation of the train of light left in most cases by those meteors, and which though generally of very short duration were in these instances of long continuance.

About eight o'clock in the evening of June 12th, a brilliant meteor was seen from Angers and London, which continued some seconds; immediately after its disappearance a powerful detonation, succeeded by several smaller ones, was heard, and a fall of stones took place, one fragment weighing thirty ounces fell in a garden at Anger, upon a hard path, so that it penetrated not more than half an inch into the ground; it was taken up at the moment, and was not particularly warm.

This meteor was seen from Poitiers by M. Boisgiraud, who calls it a falling star, and compared its appearance to a Roman candle. He does not appear to have heard any sound. It left a luminous train, straight, small above, but augmenting in diameter to a spot but little distant from its lower termination. This spot was also the most brilliant part, it subtended a sensible angle, and continued a long time; the light of the train in this part was equal to that of the moon. By degrees, this line of light changed its form, and became serpentine, and its intensity diminished. In a few minutes it divided into two parts; the upper being the larger, and in about ten or twelve minutes after their first appearance they had both faded away, with the exception of the nucleus or bright spot. Before a telescopic observation could however be made, this also had faded away.

M. Boisgiraud took particular notice of the position of this nucleus, with respect to the stars, and notwithstanding it continued for a quarter of an hour, found it invariable. The meteor appeared in the N.N.E., and the wind blew from the S.S.W.

The other meteor was observed at Paris, by MM. Gay-Lussac and Berthier. About eight o'clock in the evening of August 6th, they suddenly beheld a bright light, and raising their eyes, saw a large and beautiful luminous serpentine train of light as thick as the wrist, and appearing to be in the vertical plane passing by the place where they stood. It extended to within

thirty degrees of the horizon, and appeared to occupy an equal space. The lower part or head was most brilliant, and the light diminished (with the exception of a few points) towards the other extremity, or tail. This meteor was strongly undulated, and continued full *five minutes,* during the whole of which time it did not change its place. The light gradually diminished, and the tail faded first, the head remaining visible longer than the rest.

The meteor was seen at Caen, at the same time. It appeared to descend vertically, giving out a light equal to that of brilliant lightning, and throwing out sparks. It left a long luminous undulating tail, filled with sparks. It was seen also at Havre, Mons, Cherbourg, and Southampton.

M. Gay-Lussac then observes, " Whatever be the nature of these meteors, and which will probably remain long unknown, it appears to me incontestable that they, as well as falling stars, come from beyond the atmosphere, and that they inflame on penetrating it. In fact, their great rapidity supposes of necessity a considerable projectile force; but if the matter of which they were formed, existed in the atmosphere previous to their inflammation, it would be impossible to conceive of it otherwise than as elastic fluid, and when it inflamed, it could receive no projectile motion, nor produce that luminous train rapid as lightning, which accompanies this kind of meteors. It must therefore be in some other state than that of an elastic fluid, and consequently quite foreign to the atmosphere. If this matter should be volatile as well as the product of its combination with oxygen, it would be dissipated in smoke in the very place where it burnt; and if this were the case, we should despair of ever collecting it at the surface of the earth, and consequently of arriving at a knowledge of its nature.—*Ann. de Chim.* xx.

3. *Aerolite.*—An aerolite fell in the Commune of la Baffe, department des Vosges, on the 13th September last. A violent thunder storm commenced about four o'clock, A. M., the air being quiet, but the sky filled with electric clouds. The lightning was very intense and abundant, and frequently directed to the ground. The thunder was loud and sharp. At seven A. M. the storm was over the place abovementioned, when the inhabitants suddenly heard a noise quite distinct from the thunder, like that of a carriage descending with violence over a rough road. Its direction, like that of the storm, was from S. W. to N. E. Its duration full seven minutes, and its intensity at last frightful.

An inhabitant, Nicholas Etienne, was at this time on the road with his waggon; being alarmed he stopped, and heard a clattering noise mingled with the principal sound, and at last a dull explosion when the meteor struck the ground. At the moment

of the explosion he saw the meteor burst, and fragments passing to the side opposed to that of the storm. The explosion was neither accompanied nor preceded by lightning, or any other luminous appearance. After his alarm had subsided, he examined the place, about twelve steps off, where the explosion took place; he found a round hole in the pavé, the surface was smoked, and the bottom held the pieces of a stone, black at the surface, gray within, granular, friable, and with various brilliant points, and ferruginous threads in the metallic state; it was depressed on its inferior surface, and rounded on other parts. Its size was about that of a six-pounder shot. He thought, at first, it was hot, but having moistened it, found its heat very supportable. At the moment this phenomenon happened the storm was near the zenith; the thunder sounded before and after with the greatest force, and the rain fell with more violence.

After examination shewed that the soil where the aërolite fell was sandy, and contained no stones like those that had fallen. The evidence of all the inhabitants also went to prove that the air was calm at the time, so that no whirlwind could have carried the stone with it. If this relation is exact, and it seems well authenticated, for it is attested by the Mayor of Baffe, by Nicolas Etienne, *&c.*, it becomes a question whether, in this case, the aërolite had its origin from the storm, or whether it was mere accident that they occurred simultaneously, or whether there was any general cause for the two effects. It is also important to know what the nature of this aërolite is. On all of which points we shall probably have information from the French philosophers shortly.—*Ann. de Chim.* xxi. 17.

4. *Remarkable Aërolite.*—Signor Angelo Bellani, of Pavia, has published an essay in the *Giornale di Fisica*, v. p. 47, "on the fall of an ancient aërolite," not mentioned in catalogues. Besides the hypothesis advanced, the following is a principal feature in the account, and is extracted from a work in the Settalian Museum, published at Tortona in 1677, under the title of "*Museo o Galeria adunato dal sapere e dallo studio del Sig. Canonico Manfredo Settala nobile Milanese, descritta in Italiano da Pietro Francesco Scarabelli. Tortona*, 1677." Settala was still living, aged 84, as we read on the portrait prefixed to this edition.

In the 18th chap. of this book is the following passage: "It seems evidently demonstrated that thunder ought to be attributed to a solid and stony substance, and not to an exhalation of any kind; as is proved by one of those stones projected from the clouds, which struck with sudden death a Franciscan friar of Santa Maria della Pace, at Milan, and which is open to the inspection of every body in our Museum. I will relate the cir-

cumstances of this event, that no one may doubt its authenticity. All the other monks of the convent of St. Mary hastened up to him who had been struck, as well from curiosity as from pity, and among them was also the canon *Manfredo Settala.* They all carefully examined the corpse, to discover the most secret and decisive effects of the shock which had struck him. They found that it was in one of the thighs, where they perceived a wound blackened either by the gangrene, or by the action of the fire. Impelled by curiosity, they enlarged the aperture to examine the interior of it; they saw that it penetrated to the bone, and were much surprised to find at the bottom of the wound a roundish stone which had made it, and had killed this monk in a manner equally terrible and unexpected. This stone weighed about a quarter of an ounce, it had a sharp edge, and its surface resembled one of those silver coins which are current at Milan under the name of *Filippo.* It was not, however, perfectly round, having on one side a rather obtuse angle. Its colour varied so, that on one part it was that of a burnt brick, and on the other it seemed to be covered with a thin ferruginous shining crust. Being broken in the middle it emitted an insupportable smell of sulphur." This appears to be the only instance known, in which these stones have killed or wounded persons.

5. *Earthquake at Aleppo.*—Violent earthquakes, which began August 13, and continued, at times, to the 16th, have almost destroyed Aleppo. It is said that two-thirds of the houses were made ruins. The Captain of a French vessel reported that two rocks at the time of the earthquake had arisen from the sea in the neighbourhood of Cyprus, which is almost under the same latitude as Aleppo.

6. *Earthquake.*—A smart shock of an earthquake was felt at Dunston, near Newcastle-upon-Tyne, between one and two on the morning of September 18th, accompanied by a loud noise like distant thunder.

7. *Dutrochet on the Influence of Motion on the Direction of Vegetables.*—The following is an extract from a memoir, by the above philosopher, and is translated almost verbatim from the *Journal de Physique.*

The experiments of Messrs. Hunter and Knight on the direction taken by the plumula and radicle of germinating grains, when subjected to an uninterrupted rotary motion, are well known. Hunter observed that a bean placed in the centre of a barrel full of earth, and moved by water round its horizontal axis, had its radicle directed along the axis of the barrel. M. Knight found that grains, placed on the circumference of a

vertical wheel, rotating rapidly, directed their radicle towards the circumference, and their plumula towards the centre. When the wheel was horizontal, the radicles affected a direction intermediate between a vertical and a horizontal line, but tending towards the circumference; the plumula took an analogous direction, tending towards the centre. M. Dutrochet has repeated and verified these experiments, and having extended them, has arrived at the following results:

When the grains are placed at the circumference of a vertical wheel turning with a certain rapidity, the radicles are constantly directed towards the circumference and the plumula towards the centre.

When the rotation is very slow, so that there is no appreciable centrifugal force; the radicle and the plumula are directed in the line of a tangent, the first advancing or going with the motion, the latter receding, or going in opposition to the motion.

When the grains are placed at the circumference of a horizontal wheel turning with great rapidity, the radicle and plumula direct themselves in a perfectly horizontal direction, the first towards the circumference, and the second towards the centre. The more the motion is diminished, the greater the tendency in these parts to resume their natural direction towards the earth and the heavens.

When the grains are placed at the centre of a vertical wheel, of which the axis has a very slight inclination; the radicle and the plumula direct themselves parallel to the axis, the first towards the descending, and the second towards the ascending, part.

When the axis is perfectly horizontal, the radicle and plumula direct themselves according to the tangent of the small circle the grain describes in turning round itself; then, as in the preceding experiments, the radicle advances forward, the plumula moves backwards.

If whilst a grain turns on itself, the axis being perfectly horizontal, it be subjected to a succession of small blows or taps continually in the same direction, the radicle will direct itself in the line of the blow; the plumula, on the contrary, will move in the opposite direction from the blow; by this means, these parts may be directed at pleasure.

It results from all these facts, that the radicle constantly directs itself in the direction of the movement, or tendency, of which it feels the influence, and that the plumula as constantly directs itself in the opposite direction to that of the movement, or tendency, of which it feels the influence. So that with the radicle there is *obedience* to the exterior cause which influences it; whilst, on the contrary, with the plumula there is *re-action* against the exterior cause which influences it. Thus

the radicle and the plumula have a diametrically opposite manner of feeling the influence of this external cause, since they act in a manner diametrically opposite under its influence.

M. Dutrochet regards this phenomenon as perfectly analogous to that which, in natural philosophy, is called *polarization.* It may be said that a body offers the phenomena of polarization when two of its parts, situated diametrically opposite to each other, possess opposite properties; and it is this which exists with regard to the radicle and the plumula of seminal embryos. The same may be stated with regard to the leaves of vegetables, of which the two opposite faces are polarized inversely one to the other. M. Dutrochet has assured himself of the truth of this last fact, by submitting stalks furnished with leaves to continual rotation. The leaves turned their upper surfaces towards the centre of rotation, and consequently their lower surfaces towards the circumference. Thus the upper surface of leaves is polarized as the plumula, the lower surface as the radicle.

The general result of these observations is, that the direction of the radicle towards the centre of the earth, and of the plumula upwards, arises from this, that the *obedient pole* of the little plant, *i. e.*, the radicle, obeys the tendency of gravitation, and that the *re-acting pole* of the plant, or the plumula, re-acts against the same tendency.

The direction of the upper faces of leaves, and of stems in general, towards the light, arises from the circumstance that these parts being the seat of the *re-acting pole*, direct themselves by that alone, in the direction opposed to that of the light itself. The lower surfaces of leaves, like the radicle, flies from the light, *i. e.*, they move in the same direction as the light, being the seat of the *obedient pole*.

The facts referred to in these conclusions are good, but we will leave it to our readers to determine, whether the explanation given of them is any thing more than a play upon words.

8. *Trifolium Incarnatum.*—The professor of agriculture in the university of Modena strongly recommends a species of clover, that has not hitherto been cultivated in this country, namely, the *trifolium incarnatum*, or crimson clover. He recommends it as the earliest of trefoils; as the most useful for increasing forage; as requiring only one plowing and harrowing to cover the seed; as peculiarly calculated for dry soils, even gravels; and as preferring the mountain to the plain. It is so hardy that it may be sown even in autumn, and it stands severe frosts well. If sown in spring it will yield a good crop that year.—*New Mon. Mag.*

9. *Green Ore of Uranium.*—Mr. Phillips has ascertained

that the green ore of uranium from Cornwall contains phosphoric acid, and not merely the oxide of uranium and copper combined with water.

10. *Porcelain Clay—Gold in Cheshire.*—A superior clay, said to be well adapted for the manufacture of the best sort of china, has recently been discovered on the estate of Mr. Ackerley, at Little Saughall, near Chester. This clay is now in progress of trial, and it is expected that a pottery will soon be established on the place. It is stated also that Mr. Ackerley procured small grains of gold, from some of the strata through which he has penetrated in search of coal.

11. *Coal Seam.*—A seam of coal, six feet three inches in thickness, was come at lately in the new colliery at Helton, at a depth of 654 feet. It is to be hoped the owners of the colliery will find in it a reward for their perseverance and exertions.

12. *Inoculation and Vaccination.*—Daniel Bernouilli calculated that the inoculation of the small-pox has been the means of prolonging human life by three years, and the new observations of Duvillard gave the same result from vaccination.

13. *Fracture of Calculi in the Bladder.*—An instrument has been invented, and, it is said, brought to perfection in Paris, by M. Amusat, the use of which is to break down calculi in the bladder, and render the fragments so small that they may be voided as gravel. The instrument consists of pincers which are confined in a tube not larger than a sound, until introduced into the bladder. They are then opened, the stone is seized with facility, and by moving the handles in a particular manner, is soon reduced to powder. In a few seconds, a stone the size of a nut is broken with facility; it appears, however, that as yet the trial has been made only on a *dead* body. It still remains to be learned what the result will be in a living one.

14. *Prussian Travellers.*—The Prussian naturalists, Drs. Ehrenberg and Hemprich, in their tour in the interior of Northern Africa, arrived safely at the celebrated Dongola, the capital of Nubia, on the 15th February. These zealous collectors have sent six remittances to Berlin, and have again accumulated more than they can pack in 20 chests. Their collection consists of mammalia, birds, amphibia, insects, plants, and, what are more rare, fishes and insects of the Nile.

15. *New Series of the Geological Transactions.*—The Geolo-

gical Society has just published a half volume of transactions, being the commencement of a new series. It contains the following papers: On the Geology of the Southern Coast of England from Bridport to Babbacombe Bay, Devon. By *H. T. De la Beche, Esq.* On the Bagshot Sand, by *Henry Warburton, Esq.* On a Freshwater Formation in Hordwell Cliff, by *Mr. Webster.* On Glen Tilt, by *Dr. Mac Culloch.* On the Excavation of Valleys by Diluvian Action, by the *Rev. Professor Buckland.* On the Genera Icthyosaurus and Plesiosaurus, by *the Rev. W. Conybeare.* Outline of the Geology of Russia, by *the Hon. William T. H. Fox Strangways.* On the Geology of the Coast of France, Department de la Seine Inferieure, by *H. T. de la Beche, Esq.* On the Valley of the Sutluj, in the Himálaya Mountains, by *H. T. Colebrooke, Esq.* On the North-Eastern Border of Bengal, by *H. T. Colebrooke, Esq.*, with various other papers, and notices; the whole illustrated by 24 plates, maps, and sections, many of them coloured.

16. *On the Native Country of the Potato.*—Since the publication of my paper on the Native Country of the Potato, or *Solanum tuberosum*, in a late number of "the *Quarterly Journal*," the wild potato has been gathered in Chili by Mr. Caldcleugh, a gentleman who has been several years resident in South America, and two roots brought by him from thence, have been cultivated in the garden of the Horticultural Society. The roots, although very small, grew remarkably luxuriant, and the stems produced by them covered a space full four yards in circumference. Being planted in too rich soil, they produced almost no tubers, but in their stead threw out numerous subterraneous shoots or suckers. The stems and leaves were rougher and more rigid than in the cultivated potato, and the flowers somewhat smaller. The leaves at first were equally pinnate, as described by M. Dunal in *Solanum commersonii;* but, as the plant advanced to flower, they lost this character, and became unequally pinnate ar in the cultivated potato. This plant, I have no doubt, is identical with the *S. commersonii* of Dunal, and confirms the opinion which I formerly advanced, that *S. commersonii* is the *Solanum tuberosum* in a wild state. After a careful comparison of this plant with different varieties of *Solanum tuberosum*, I have not been able to discover a single character by which they could be separated as distinct species, and the differences observable between them are of little botanical importance in this tribe of vegetables, and are merely what would be expected to exist between the wild and cultivated state of the same species. I have been induced to say thus much on this subject, having formerly ventured an opinion respecting these two plants being of the same species.

17. *Landslip.*

To the Editor *of the Journal of Science.*

Sir,

An example of a landslip, or what in the olden time would have been called a walking hill, occurs near Camberwell, four miles and a half south of London, at Knight's Hill, upon an estate which was the property of the late Baron Thurlow. The ground has been observed for many years to slip or give way after a continuance of wet weather; but the autumn of 1821 being remarkable for a great quantity of rain, has caused a greater subsidence than on any former occasion.

The part that has given way extends in an irregular direction on the north and west sides of the hill, seven or eight hundred yards in length, and varying from twenty to a hundred in breadth, containing altogether about five or six acres. It has carried several trees along with it, but they still continue growing; the green sward possessing great tenacity, has been thrown into most singular contortions, bearing some resemblance to old entrenchments. The higher part of the hill is full of rents and fissures. The depth of the landslip is apparently about two or three yards.

A long continuance of wet would perhaps be the means of extending it over the road which passes at the foot of the hill, and upon which it seems to have already encroached in a trifling degree.

Knight's Hill is part of the London clay formation, and the landslip is of course occasioned by the strata underneath not being sufficiently porous to carry off the water.

I have the honour to be, &c.

J. Finch.

London, Oct. 15, 1822.

ART. XVIII.—METEOROLOGICAL DIARY for the Months of September, October, and November, 1822, kept at EARL SPENCER's Seat at Althorp, in Northamptonshire.

The Thermometer hangs in a North-eastern Aspect, about five feet from the ground, and a foot from the wall.

For September, 1822.

Day	Date	Thermometer Low	Thermometer High	Barometer Morn.	Barometer Eve.	Wind Morn.	Wind Eve.
Sunday	1	44	65	29.99	29.98	W	W
Monday	2	46	68	29.93	29.84	WSW	WbS
Tuesday	3	53	70	29.80	29.75	W	W
Wednesday	4	47	68	29.77	29.67	W	WNW
Thursday	5	58	70	29.78	29.68	SW	SW
Friday	6	59	71	29.67	29.67	WbS	W
Saturday	7	46	63	29.90	29.90	W	WbS
Sunday	8	52	67.5	29.78	29.80	WbS	W
Monday	9	48	65	29.80	29.77	W	W
Tuesday	10	43	63	29.94	30.00	W	W
Wednesday	11	40	65	29.80	29.99	SW	SW
Thursday	12	45	63	29.79	29.89	W	NW
Friday	13	49	60	29.60	30.00	NE	NE
Saturday	14	34	61	30.10	30.08	ENE	E
Sunday	15	47	61	29.90	29.98	E	E
Monday	16	42	68	29.88	29.83	E	SW
Tuesday	17	43	71	29.88	29.90	W	SE
Wednesday	18	51	65	29.92	29.91	N	ENE
Thursday	19	47	64	30.06	30.00	E	E
Friday	20	48	63	29.84	29.84	E	E
Saturday	21	43	61	29.74	29.74	ENE	NE
Sunday	22	45	61.5	29.75	29.80	E	ENE
Monday	23	50	60	29.72	29.54	E	E
Tuesday	24	51	59	29.24	29.25	E	NE
Wednesday	25	56	58	29.16	29.43	N	N
Thursday	26	42	56	29.51	29.88	NE	NE
Friday	27	39	56	29.95	30.12	NE	NE
Saturday	28	45	58	30.08	30.08	E	EbN
Sunday	29	46	57	29.90	29.89	NE	NbW
Monday	30	30	58	29.69	29.69	E	EbS

For October, 1822.

Day	Date	Thermometer Low	Thermometer High	Barometer Morn.	Barometer Eve.	Wind Morn.	Wind Eve.
Tuesday	1	40	59	29.58	29.63	EbN	E
Wednesday	2	47	65	29.57	29.63	E	ESE
Thursday	3	56	65	29.50	29.50	E	SE
Friday	4	50	63	29.50	29.50	SW	SW
Saturday	5	53	65	29.52	29.37	SE	W
Sunday	6	45	55	29.33	29.40	WbS	WbS
Monday	7	45	60	29.20	29.43	SW	SW
Tuesday	8	50	56	29.34	29.41	WSW	WbS
Wednesday	9	45	63	29.54	29.41	SE	WbS
Thursday	10	44	60	29.58	29.71	W	WbS
Friday	11	37	61	29.90	30.00	W	S
Saturday	12	49	58.5	29.81	29.60	SE	ESE
Sunday	13	50	61	29.32	29.37	SE	NE
Monday	14	39	52	29.77	29.87	NE	NW
Tuesday	15	33	51.5	29.79	29.60	W	SW
Wednesday	16	43	49	29.30	29.27	E	NE
Thursday	17	41	47	29.27	29.33	NE	NE
Friday	18	32.5	49	29.50	29.50	WbN	NE
Saturday	19	40	53	29.53	29.24	SE	SW
Sunday	20	41	55	29.24	29.27	SbE	SW
Monday	21	45	56.5	29.37	29.37	WSW	WSW
Tuesday	22	34	56	29.60	29.62	SW	SW
Wednesday	23	33	55	29.60	29.40	SE	SE
Thursday	24	41	58	29.28	29.25	SE	SE
Friday	25	52	59	29.27	29.36	SSE	SSE
Saturday	26	41	54	29.40	29.32	E	ESE
Sunday	27	46	55	29.35	29.45	W	SW
Monday	28	30.5	52	29.62	29.70	SW	SE
Tuesday	29	40	54.5	29.70	29.86	SW	NW
Wednesday	30	49	57.5	29.82	29.77	SE	SE
Thursday	31	48	59	29.57	29.52	SE	SE

For November, 1822.

Day	Date	Thermometer Low	Thermometer High	Barometer Morn.	Barometer Eve.	Wind Morn.	Wind Eve.
Friday	1	47	57	29.60	29.60	SW	SE
Saturday	2	52	58.5	29.19	29.50	S	WbS
Sunday	3	45	54	29.80	29.68	WSW	W
Monday	4	37	51	30.06	30.19	SW	W
Tuesday	5	45	53.5	30.10	30.00	W	WbS
Wednesday	6	47	53	30.00	29.91	WbS	SW
Thursday	7	40	52	29.78	29.75	SSE	SW
Friday	8	42	50	29.75	29.79	WNW	NW
Saturday	9	30	44	29.91	29.74	WbN	SE
Sunday	10	41	49	29.60	29.88	E	WbN
Monday	11	39	49	30.07	30.06	SE	S
Tuesday	12	45	52	29.90	29.80	SW	SW
Wednesday	13	36	47	29.77	29.62	SE	WSW
Thursday	14	37	46	29.19	29.30	WSW	WSW
Friday	15	39	45.5	29.00	29.03	SW	WbS
Saturday	16	38	41	29.23	29.18	NW	NW
Sunday	17	33.5	47	29.40	29.47	SW	SW
Monday	18	42	51.5	29.38	29.50	SW	SE
Tuesday	19	41	53.5	29.62	29.54	S	SW
Wednesday	20	42	51.5	29.52	29.51	S	SW
Thursday	21	43	48	29.39	29.53	SW	WbS
Friday	22	35	47.5	29.64	29.46	SW	W
Saturday	23	39	49	29.37	29.37	SW	bW
Sunday	24	38	50	29.66	29.54	SW	SE
Monday	25	42	49	29.33	29.31	SE	SE
Tuesday	26	41	48.5	29.31	29.33	SW	SW
Wednesday	27	42	47	29.35	29.40	SW	SW
Thursday	28	33.5	43	29.36	29.13	SE	SE
Friday	29	31.5	41	29.25	29.07	SW	SW
Saturday	30	31	40	29.10	29.20	SW	SW

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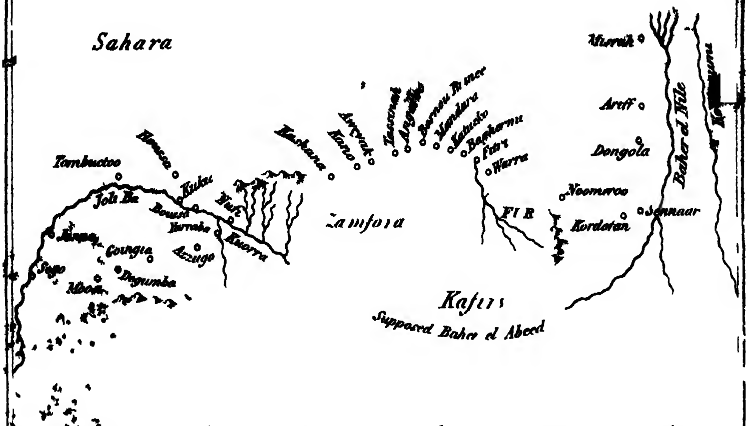
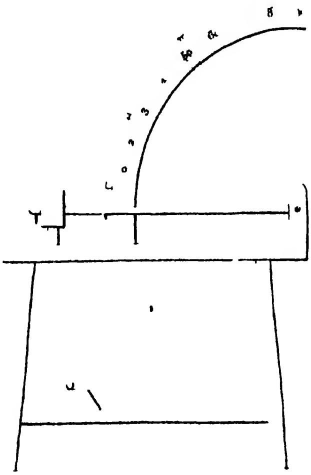


Mahomed Misrah's Route from Egypt to Western Africa



M. Regnier's Dactilometer

James Basire sculp

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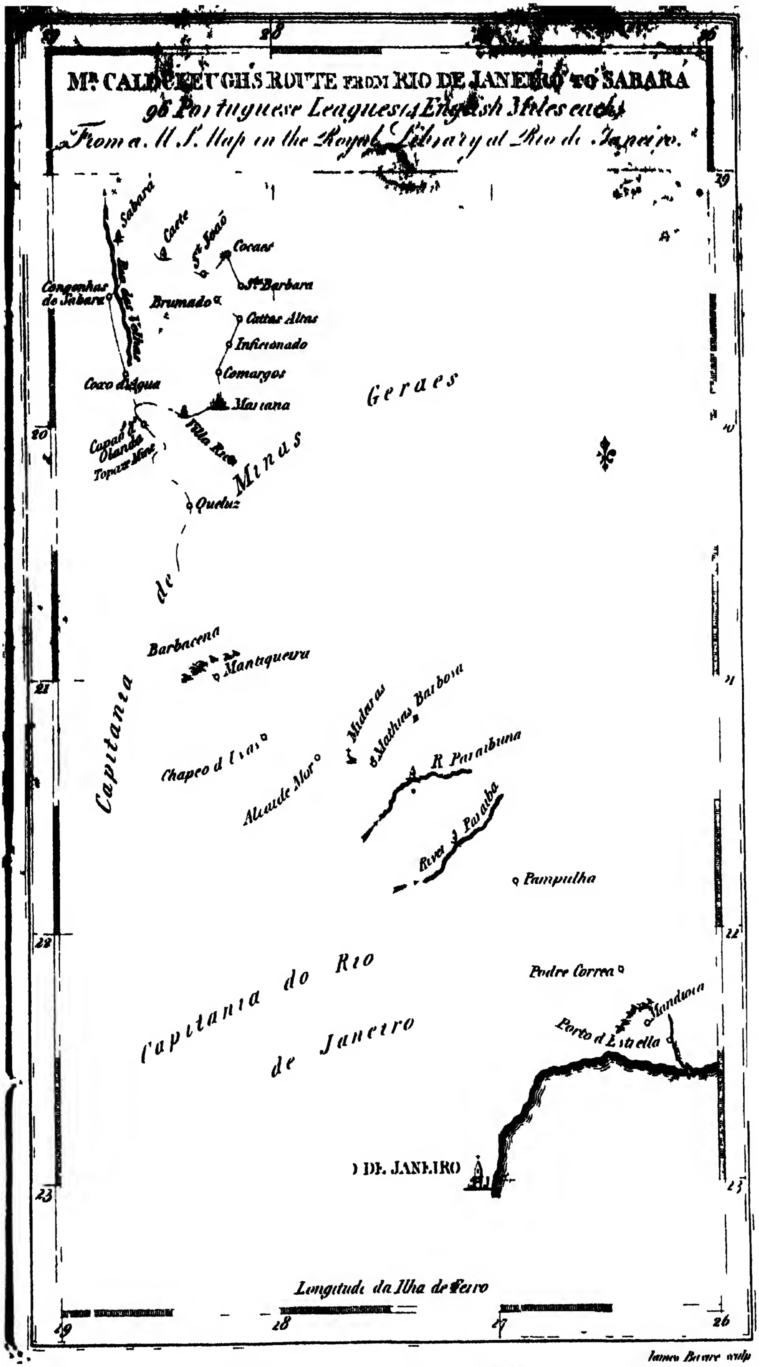

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